EXAMINING PLACE INFLUENCE ON ALCOHOL RELATED BEHAVIOUR AND HEALTH OUTCOMES IN NEW ZEALAND

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Table of contents

Abstract

Much of the literature on the determinants of health, including alcohol consumption, has focussed on differences in individual socio-economic status as a primary risk factor. However, it has been shown that variation in health between places can be attributed to both the characteristics of the people who live in those places (composition) and also to the characteristics of the places where people live (context). From the 1990s, there has been considerable interest in the role of neighbourhoods, specifically whether their social and physical characteristics are important in explaining inequalities in health. The main aim of this thesis is to determine the influence of 'place' effects on alcohol-related behaviour and health and social outcomes in New Zealand.

To achieve this, data was obtained for hospitalisation and mortality directly related to alcohol consumption. Age standardised rates of alcohol related hospitalisation and mortality were calculated for different census areas units over time. Secondly, a database of all alcohol outlets including type and category was obtained from the Liquor Licensing Authority and geocoded for all meshblocks in New Zealand. Using ArcGIS road network functionality, least cost distance to nearest alcohol outlets was calculated. In addition, two buffers (800 and 3000 metres) were created around the population weighted centroids of each meshblock. Statistical analysis was undertaken to examine the distribution of alcohol outlets in areas of differing socio-economic status. Thirdly, binary logistic regression was used to examine the relationship between various access measures developed and individual alcohol related behaviour from the New Zealand Health Survey (2006/07). Lastly, Ordinary Least Squares regression was used to establish the association between the density of alcohol outlets and crime, and alcohol related hospitalisation.

The results reveal there is increasing geographic inequality of both hospitalisation and mortality between the most and the least deprived areas in New Zealand. Secondly, the results consistently show there is inequity in the availability of alcohol outlets; there are clear social patterns in the distribution of alcohol outlets with disproportionately high numbers in more socially deprived neighbourhoods. Thirdly, at the national level, after controlling for potential confounding factors, there was no association between

either hazardous or frequent consumption of alcohol and access to alcohol outlets. However, there was an association for particular sub-populations in regards to hazardous and frequent consumption and access to alcohol outlets. Fourthly, although the explained variance was often quite low in outcome models for crime and hospitalisation, nevertheless most of the variance for crime was predicted by the density of alcohol outlets.

A number of important theoretical and policy implications flow from this study. Alcohol outlets are modifiable structures in the environments that are amenable to policy interventions at a community and national level. Interventions could concentrate on three aspects to reduce excess consumption; zoning ordinances, reducing alcohol outlets in deprived areas and increased alcohol taxation. Starting with the first proposed intervention, zoning ordinances provide communities and local governments with the opportunity to regulate outlet numbers and locations as well as their trading hours. This intervention has the potential to reduce opportunities for obtaining alcohol. Secondly, a reduction in the number of alcohol outlets is likely to reduce consumption and consequently improve health and social outcomes. Finally, higher alcohol prices via increased taxation is likely to be a deterrent to excess consumption and related health outcomes. Three priority areas are identified and recommended for future research. Studies using a mixture of both qualitative and quantitative methods, to better understand the association between local purchases of alcohol, consumption and proximity to alcohol outlets would be beneficial. In addition, the use of qualitative methods to examine the influence of social capital and cohesion, culture and norms on alcohol consumption in areas with higher densities of, and better access to alcohol outlets, is imperative. Lastly, longitudinal studies are also recommended to investigate increases or decreases in the number of alcohol outlets over time and the impact of such changes on the consumption patterns of different sub-populations.

List of Tables

List of Figures

List of Appendices

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Abbreviations and Acronyms

ALAC	Alcohol Liquor Advisory Council (New Zealand)
ASIR	Age specific incidence rates
AUDIT	Alcohol Use Disorders Identification Test
BAC	Blood alcohol concentration
BMI	Body mass index
BRFSS	Behavioural Risk Factor Surveillance System
CAU	Census area unit
CHD	Coronary heart disease
CRA	Comparative risk assessment
GIS	Geographic information system
ICD	International Classification of Disease
IRR	Incidence rate ratio
NHS	National Health Service (United Kingdom)
NIAAA	National Institute On Alcohol Abuse And Alcoholism (United States of America)
NZ	New Zealand
NZDep	New Zealand Deprivation Index
NHI	National Health Information
NZHIS	New Zealand Health Information System
NZHS	New Zealand Health Survey
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary least squares regression
ONS	Office of National Statistics
ORs	Odds Ratios
PPS	Proportional size sampling design
SEGI	World ‘population’, devised in the late 1950s by cancer epidemiologist Dr Mitsuo Segi, was based on the sum total of male and female populations of the 46 countries in the 1950 publications of the WHO (Segi, 1960).
SMR	Standardised mortality ratio
SES	Socio-economic status

SPSS	Statistical Package for the Social Sciences
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation

Chapter 1 Introduction

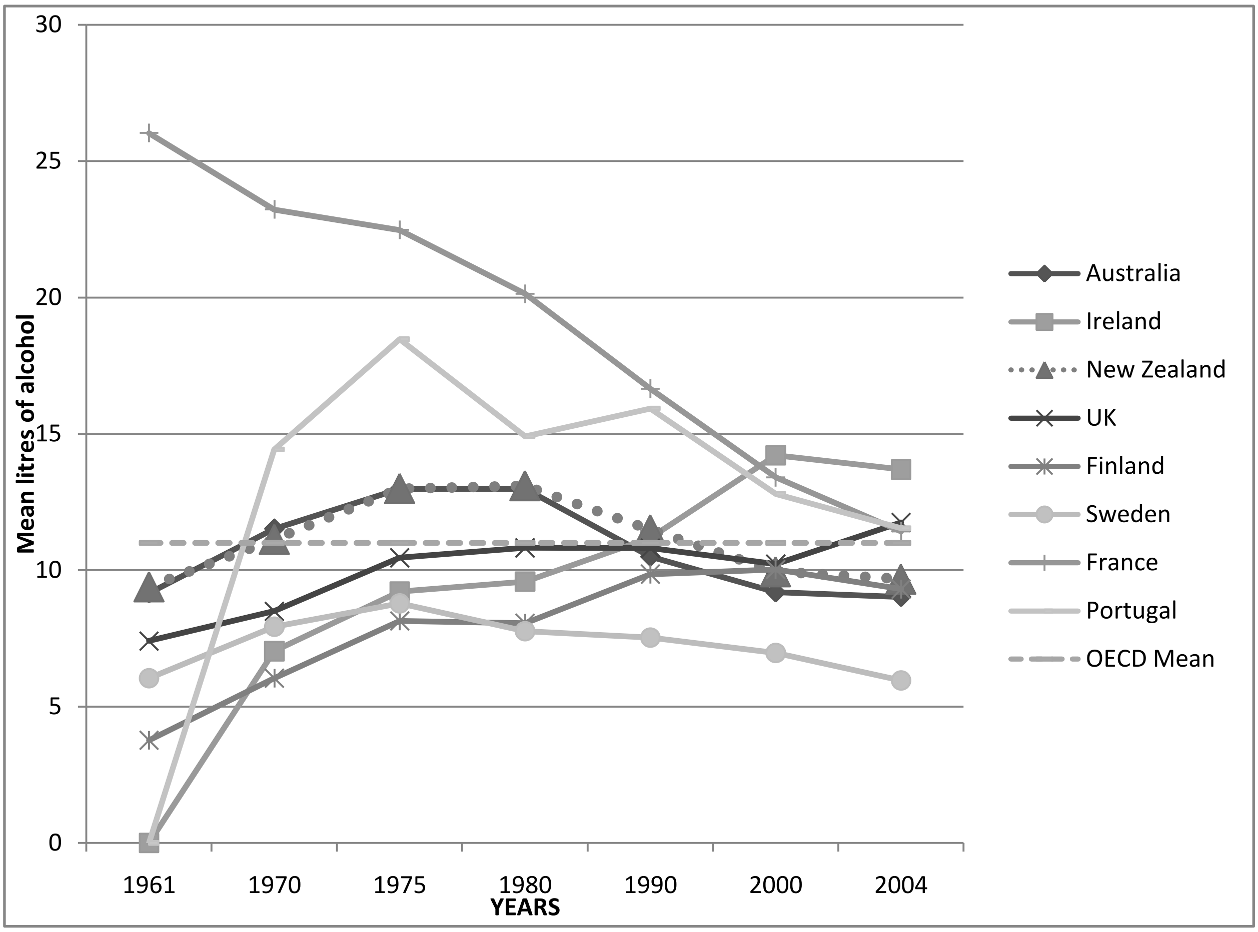
1.1 Background

The World Health Organization (WHO) estimates that there are currently two billion people who drink alcohol and about 76.3 million who have drinking disorders. Of these, 63.7 million are male and 12.7 million are female (WHO, 2002). Alcohol has both positive and negative consequences depending on consumption. On one hand there is an inverse relationship between moderate alcohol consumption and coronary heart disease (CHD) (Gunzerath et al., 2004, Rimm et al., 1991). On the other hand, hazardous consumption is associated with oesophageal cancer, epilepsy, unintentional injuries, homicide, motor vehicle accidents, intoxication, alcohol poisoning, pancreatitis and cirrhosis of the liver (WHO, 2004). The WHO *Global Status Report on Alcohol* (2004) reported that 5.5 percent of the entire disease burden in the Western Pacific Region, where New Zealand is located, is attributed to harmful alcohol consumption. This is significantly higher than the global level of 4 percent.

Alcohol consumption varies between different regions and countries. For example, there are differences between countries of the Organisation for Economic Cooperation and Development (OECD) and less developed nations, with average consumption higher in the former. As might be expected, in countries where Islam is the dominant religion, low alcohol consumption is recorded, particularly in the eastern Mediterranean region, the Indian subcontinent and some Muslim states in the former Soviet Republic and Yugoslavia (WHO, 2004). There are also further differences in alcohol-related health behaviour, especially in terms of hazardous alcohol consumption, between rich and poor countries, between developed and developing nations, and more specifically between former communist and non-communist states. However, Rehm et al., (2003) argue that many of these differences are only temporary and that it is only a matter of time before the developing world and poor nations have the same alcohol-related health problems as the developed world.

Even within the OECD countries, alcohol consumption rates vary between countries and over time. Figure 1.1 indicates that per capita consumption peaked in most countries, including New Zealand, in the late 1970s or early 1980s, and declined significantly thereafter, with only Ireland and Finland recording increasing alcohol consumption in recent years.

Figure 1.1: Mean per capita consumption of litres of pure alcohol



Data tabulated from WHO statistics

Despite this general reduction in average alcohol consumption and the number of people consuming alcohol in many countries, there has been a significant increase in the consumption of more than recommended amounts of alcohol (WHO 2002). For example, in the European Union, many member states report a reduction in general consumption but a significant increase in harmful drinking (Hibbell et al., 2009). Because of this change in drinking patterns, Rehm et al., (2003) argue that in the last 25 years, alcohol-related harm has increased in many countries, especially among younger age groups (15–29 years) who are more likely to consume excessive alcohol in one drinking session (Babor et al., 2003, WHO, 2002). The WHO has attributed this youth drinking to a new cultural trend, where people consume alcohol in order to get to get drunk, in a manner not only tolerated but approved of by peers. This new culture might be because of people’s preference for beer and spirits instead of wine which has traditionally been consumed moderately (WHO 2004).

The rise in harmful drinking amongst younger people is particularly noticeable for women, especially those aged 15–19 years. The rising consumption among younger women has been exacerbated by the alcohol industry, especially with the introduction of light beer and alcopops (a mixture of sweet carbonated juices and spirits) (Huckle et al., 2008b). This increase in excess alcohol consumption by different sub-populations is a significant contributor to ill-health and therefore inequality, especially with an increase in conditions such as pancreatitis amongst the younger age groups, a disease previously more prevalent in elderly (O'Farrell et al., 2007).

Although there is evidence that ill-health is caused by excessive alcohol consumption, contributing to increased social and geographic inequalities in health status, studies have focussed more on the dose-response relationship between excessive alcohol consumption hospitalisation and negative health outcomes (Makela, 1999, Makela, 1998, Hingson et al., 2009, Marin-Leon et al., 2007, Leon et al., 2007). Such studies have also indicated that, in any given area, alcohol-related mortality is related to deprivation as well as socio-demographic characteristics. While studies for alcohol-related health outcomes have been fairly consistent in their findings, this has not been the case for alcohol consumption.

Alcohol consumption studies have shown some inconsistency, especially in explaining why some groups are more affected than others. For example, when consumption is examined, people of higher socio-economic status (SES) are more likely to drink more frequently than those in less affluent groups. On the other hand, people of a lower SES are more likely to engage in more harmful drinking and to exhibit a higher prevalence of risky health behaviours (Marmot, 1997, van Oers et al., 1999). Interestingly, recent research from developing countries has found that higher, rather than lower SES was associated with higher rates of alcohol consumption and dependence (Almeida-Filho et al., 2005). The reason for this discrepancy is disputed with traditional researchers focussing on individual determinants and new public health geographers suggesting that the answer lies in contextual or environmental factors. Moreover, these studies have focussed on alcohol consumption patterns amongst different groups, but not on consumption as an outcome, relegating consumption to a variable to be controlled for in health research.

In view of the above observations, the remainder of this chapter examines the traditional focus of alcohol research and argues that contextual or neighbourhood factors are also important in understanding the social differences in alcohol consumption. In light of the gaps noted in alcohol research, the aim and objectives of the study will then be identified.

1.2 Traditional focus of alcohol consumption research

Historical interest in alcohol consumption can be traced back to the early concerns of Benjamin Rush in the United States of America (USA) and Thomas Trotter in Scotland in 1785. In 1838 the first alcohol-related deaths were published in the United Kingdom (Smith and Hanham, 1982). However, it was not until 1958 that the American Medical Association officially recognised alcoholism as a disease. Alcoholism was considered an individual problem that required medical attention since most of these early studies were able to show that higher per capita consumption was associated with mortality rates (Dawson and Room, 2000).

Most of the early studies were more interested in how consumption affects health and in whether there was dose-response relationship in terms of levels of hospitalisation and mortality. However, consumption patterns were often crudely measured, making comparisons between studies difficult (WHO 2002) and thus creating a need for better measures. According to Midanik and Room (2005), research on alcohol consumption patterns can be traced historically to the USA after the end of prohibition. In 1939, a Gallup poll was conducted which asked questions on beverage use – that is whether beer, wine, spirit were used on occasions – or whether the respondent was an abstainer (Gallup, 1972). Subsequent studies attempted to differentiate between drinkers and abstainers only (Riley and Marden, 1947). It was not until 1969 that a national survey was conducted that attempted to define consumption patterns more precisely (i.e. was the drinking spaced out over time or was it more concentrated) (Cahalan et al., 1969). In 1980, social epidemiologists developed quantity-frequency measures as concerns were emerging about the amount of alcohol consumed (Room, 1990). In the 1990s, much simpler measures were introduced and consumers were now classified as moderate, hazardous or heavy episodic drinkers (Grant, 2003, Wechsler et al., 1995). Eventually the WHO developed a standard Alcohol Use Disorders Identification Test (AUDIT). The AUDIT allowed better comparison of standardised consumption rates across nations (WHO 2004).

Since consumption measures were now better quantified, most countries undertook national surveys that measured drinking behaviour. Commentators could now differentiate between individuals based on how much alcohol they consumed. They relied on these surveys to understand individual drinking patterns and other related information, including socio-demographic characteristics, health status and alcohol-related experiences. Most importantly, the surveys have been able to distinguish hazardous from moderate or light drinkers (Dawson and Room, 2000, Alanko, 1984, Armor and Polich, 1982, Midanik and Harford, 1994, Rehm 1998, Room, 1990). Therefore, studies were able to highlight how people drink and more specifically the frequency and amount consumed.

Despite the advances in measurement techniques, traditional researchers still focussed on how consumption patterns varied between different social groups instead of examining the conditions that facilitated such consumption. The key point from these surveys is that there are individual and biological differences in determining alcohol consumption including SES, ethnicity, age, gender and genetics. Writers such as Gould (2001) and Bramley et al., (2003a) have argued that minority ethnic groups tend to be of low SES and are more likely to engage in hazardous consumption.

Traditional explanations of such group differences have ranged from individual behaviour to biological factors. For example, biologists have isolated genes in human beings that contribute to alcohol consumption or offer protection. For example, a recent genetic study found that polymorphisms in genes of the dopaminergic system appear to influence variation in drinking behaviour (Hopfer et al., 2005). Such genes are suggested to influence consumption and are inherited from parents, who were alcohol consumers (Hopfer et al., 2005, Siewert et al., 2004, Cloninger et al., 1981, Agrawal and Lynskey, 2008). In contrast, a variant of the alcohol dehydrogenase is associated with protection against alcohol dependence in Māori and other minority ethnic groups (Hall et al., 2007) thus disputing the theory that Māori have a gene for excess alcohol consumption. Employing genetic theories to explain alcohol consumption amongst ethnic groups is, however, contested. Agrawal et al., (2008) argue that alcohol addiction is multi-factorial, meaning that both environment and genetics have an effect upon it, such that excess consumption should be considered a function of many variables.

Duncan et al., (1998) further add that, as much as traditional research was important, one major limitation was that interpretation of individual data, and specifically the effects on health, often failed to consider the social processes that condition such effects. Data consisting only of individual characteristics are not useful in describing the physical or social environment (Yen and Kaplan, 1999b). Therefore, to better understand the behaviour it is important to analyse both individual characteristics and the social groups to which people belong (Susser, 1994). In addition, instead of examining consumption patterns, research should concentrate on factors facilitating excess alcohol consumption. It is against this backdrop that criticisms of the methodology, settings and data in traditional alcohol research can be examined.

1.3 Critique of traditional alcohol research

Traditional studies of alcohol consumption, which focussed on individual and group differences, often portrayed alcohol consumers as evil, irresponsible and uncontrollable. Those who consumed excessively were suggested to have lost self control and to lack the will to self regulate. The recommended remedy was prohibition and most policies advocated for state control or individual health education (Dorn, 1983). Critics of individual determinants of health say that although the inclination for health may in part be rooted in individual and biological factors, such behavioural patterns develop in a multilevel social context, encompassing personal relationships as well as societal level structural constraints and cultural traditions (Bjarnason et al., 2003). It was the failure of traditional researchers to recognise the role that the environment plays which led to criticism of their research.

First, a recent review in Europe reports that traditional alcohol research made assumptions about alcohol problems (Weinberg Group, 2006). They argue that alcohol was seen as a problem of certain groups – including young people, males, ethnic minorities or those of low SES – without investigating what other variables might influence or moderate the behaviour of such individuals and groups. Such research ignored the basic facts of why, how and when people drink, and especially the social norms that surround such consumption. Such research did not examine consumption per se, but rather the problems caused by it.

Secondly, early geographic research on alcohol consumption tended to concentrate more on ‘space’ rather than ‘place’. One of the first few individuals to emphasise the need for geographers to engage with alcohol consumption research is Smith et al., (1982). Brenner, one of the panellists in a recent review of alcohol studies in Europe (Weinberg Group, 2006), criticized traditional alcohol research as lacking rigour and said that in epidemiology there are basic rules which have been largely ignored by alcohol researchers. He asserts that most studies focussed on the effects of alcohol, thus interpreting results in isolation without considering other variables. For example, research might examine the effect of age on consumption, without necessarily examining confounders and effect modifiers. Such modifiers and confounders include a number of lifestyle and contextual factors that are associated with both consumption and health effects. These have largely been ignored, and arguably without proper reason (Weinberg Group, 2006). An examination of all the possible individual and contextual variables together can result in a firm conclusion about the phenomenon being investigated (Macintyre et al., 2002).

Furthermore, Jayne et al., (2008) argue that traditional alcohol research has ignored important contextual factors, such as increases in the density of supermarkets and liquor stores, and how these might contribute to domestic drinking. This increasing density of liquor outlets is a recent phenomenon. They argue that researchers treat context, location and relationships between people as almost inconsequential. Such studies do not take into account people’s social cohesion or group norms. Jayne et al., (2008) concluded that theoretical arguments have failed to go beyond specific people, groups and places other than classifying alcohol as a social or medical problem, or a social or cultural practice.

Thirdly, the geographic scale of investigation should be well defined and explained, since some results are inconsistent when the scales are changed. According to Jayne et al., (2008) there is a lack of research that seeks to compare or contrast research in different contexts and at different spatial scales. Some of the traditional studies were undertaken at the broader national level without taking into consideration small geographic areas and cross-cultural data. In New Zealand, alcohol research has generally not engaged with neighbourhoods and local consumption. For example, studies in New Zealand have shown that alcohol availability and access is easier in deprived neighbourhoods than in more affluent ones, as measured at meshblock level (Pearce et al., 2008a). Most of these deprived neighbourhoods are inhabited by Māori or Pacific Island peoples. Research, however, has not linked these two factors; but assumptions could be made that there are some neighbourhood features that facilitate excessive alcohol consumption amongst such minority ethnic groups. Commentators such as Diez Roux (2001) and Macintyre et al., (2002) have called for a more sophisticated focus on the social contexts in which the lives of younger age groups and ethnic minorities take place.

Fourthly, Jayne et al., (2008) argue that numerous studies of alcohol consumption have been undertaken by people from various disciplines, but while they have a geographical component they have not followed through to examine these geographical components comprehensively.

Fifthly, while many health studies have examined contextual factors, there is inadequate theory behind their research. Litvia and Eyles (1995) suggested health geography has traditionally lacked good theoretical foundations. Debate on a the new theory on health geography followed the publication of Kearns' (1993) paper where he attempted to push "...the collective focus of medical geography towards a cultural/humanistic standpoint through the advocacy of 'post medical geographies of health' (Gesler and Kearns, 2002, Kearns and Moon, 2002). While Kearns was more interested in place as an experience as opposed to location, and initiated the debate on theory, it was Macintyre and Diez Roux who started to theorise why and how 'place' or neighbourhoods might matter for health (Kawachi and Berkman, 2000). Of interest to geographers was the debate on composition and context. Compositional explanations suggest that geographical differences in health outcomes are entirely due to individual characteristics. On the other hand, contextual explanations suggest that geographical differences in health are a feature of exposure to those characteristics of an area where individuals live. To better understand health behaviour, it is important to understand the interplay between these two dimensions (Diez Roux, 2001, Macintyre et al., 2002, Tunstall et al., 2004). Identifying features of 'place' that contribute to individual excess consumption is therefore imperative.

Studies undertaken by early medical geographers tended to utilise spatially extensive data sets to investigate relationships between health, illness and environment (Haynes et al., 2003, Gatrell, 2002, Jones and Moon 1987). Such research was criticised for ignoring human experience and agency and for reducing individuals to categories, obscuring their identity in statistical analysis (Dyck and Kearns 1995). More recently, as part of the shift from medical to a more broadly defined health geography (Kearns and Moon, 2002), geographers have undertaken mixed method or qualitative investigations of the influence of particular localities on health and well-being (Conradson, 2005, Kearns and Gesler, 1998, Wilton 1999, Gesler and Kearns 2001). Conradson, (2005) for example, has contributed to work on therapeutic landscapes by examining respite centres for the physically impaired. He found that explanation for respite centres' effectiveness lay in their natural and scenic setting and being identified as areas of relaxation and healing.

It is thus important that research should unpack individual differences in alcohol consumption by examining neighbourhood features. Geographers need to address the issues surrounding neighbourhoods and consumption at these small geographic scales, rather than focussing entirely on health outcomes, which are mostly a consequence of consumption.

1.4 Neighbourhoods and health

From the 1990s there has been renewed interest in the role neighbourhoods play in influencing human health outcomes. Previously, there was a general dearth of neighbourhood studies, in addition to conceptual and methodological limitations that typify some of the previous research (Monden et al., 2006b). Since the 1990s a substantial number of studies have shown the relationship between individual health outcomes and local SES (Davey Smith et al., 1998, Ecob and Macintyre, 2000, Ross and Mirowsky, 2001) but others have no associations (Sloggett and Joshi, 1994, Veugelers et al., 2001). Consequently, there is still some uncertainty about mechanisms that relate neighbourhoods to health and how such mechanisms can be identified and measured (Diez Roux, 2001). In addition, such mechanisms may differ for specific health outcomes as well as neighbourhood characteristics (Monden et al., 2006b). Messer (2007) contends that the evidence linking neighbourhoods to health outcomes is less than clear, tends to be cross-sectional and is thus relatively weak.

Macintyre et al., (1993; 2002) thus argue that studies need to focus more on explaining the links between 'place' and health outcomes rather than describing social and health variations. Two perspectives have been suggested as being important in explaining the link between place and health. The first, the 'contagion' perspective, states that people copy behaviour that is around them and that there are certain norms and cultures that are followed in the neighbourhoods (Crane, 1991, Jencks and Mayer, 1990). On the other hand, the structural perspective proposes that neighbourhoods present their residents with both opportunities in terms of better access to resources or constraints in terms of lack of access (Aneshensel and Sucoff, 1996, Macintyre et al., 1993). To this end, neighbourhoods have been hypothesised to influence health in four main ways:

- through neighbourhood institutions and resources, including differential access to services and amenities, which may have both positive and negative impacts upon health
- through stresses of the physical environment
- through stresses in the social environment
- via neighbourhood based networks and norms (Ellen et al., 2001).

Consequently, an increasing number of studies recognise that social influences on health operate through many processes, including the types of neighbourhoods where people live (Diez Roux, 2001). A substantial number of studies have examined specific social and physical environments that promote or inhibit health and have indicated a relationship between 'place' and health behaviours (Ellaway and Macintyre, 1996) such as smoking (Barnett, 2000, Duncan et al., 1999, Kleinschmidt et al., 1995), obesity (Ellaway et al., 1997) and reduced physical activity levels (Yen and Kaplan, 1999a). These studies have demonstrated that there is an association between contextual factors and health related behaviour and outcomes over and above the characteristics of individuals living there, however, Cummins et al., (2005a) argue that such studies are rare.

What are the specific neighbourhood features that influence health behaviour? Using obesity as an example, commentators have demonstrated that less affluent neighbourhoods are ‘obesogenic’ environments as most people living there suffer increased odds of obesity (obesity being measured by body mass index (BMI)). Consequently, they examined a range of services and resources within such neighbourhoods and their relationships with obesity. The results were mixed, with studies showing that obesity was associated with the availability of fast foods and fewer stores selling healthy foods (Cummins et al., 2005b, Larson et al., 2008, Moore and Diez-Roux, 2006, Morland et al., 2002, Zenk et al., 2005) and reduced access to supermarkets (Inagami et al., 2006, Morland and Diez Roux, 2006, Morland and Evenson, 2009) while others found no association between neighbourhood food availability and obesity (Jeffrey et al., 2006, Mobley et al., 2006, Pearce et al., 2009a). Similarly, other writers have found that people with better local opportunity for physical activity have reduced their body weights (Frank et al., 2004, Mobley et al., 2006, Saelens et al., 2003). Better access and availability of recreational facilities for formal physical activity is associated with increased physical activity and reduced body weight (Annear et al., 2009, Aytur et al., 2008, Humpel et al., 2004, Titze et al., 2008, Tucker et al., 2009).

While ‘obesogenic’ research has focussed mostly on access to various resources, research on smoking has focussed on variables such as access, neighbourhood stresses of the physical and social environment, and neighbourhood based networks and norms. There is evidence that increased smoking has an association with neighbourhoods that lack or have lower social cohesion (Chuang and Chuang, 2008 , Patterson et al., 2004), neighbourhood stress (Acierno et al., 1996, Anda et al., 1990, Stead et al., 2001), social disorganisation including physical disorder and people’s perceived lack of safety (Miles, 2006, Virtanen et al., 2007), neighbourhood deprivation (Diez Roux et al., 2003, Chuang et al., 2007) and better access to tobacco retail outlets (Chuang et al., 2005). However, others studies have found no relationship between locational access and smoking (Pearce et al., 2009b), and strong networks and identity also encouraged smoking (Stead et al., 2001). Unpacking neighbourhood mechanisms that facilitate or inhibit heath is therefore of paramount importance.

1.4.1 Neighbourhoods, alcohol consumption and health outcomes

Despite evidence that neighbourhoods influence health behaviour, researchers have ignored the influence of place on alcohol consumption. Rather the spotlight has been on the relationship between area-level SES and alcohol-related health outcomes (Harrison and Gardiner, 1999, Makela, 1999, Makela et al., 2003). The focus is more on the dose-response relationship and the modifying effects of SES rather than the geographical variations highlighted because of differences in SES. In addition, these studies ignored the specific mechanisms linking SES to both alcohol consumption and alcohol-related outcomes. In particular, no attempt was made to investigate reasons linking the two. While these studies have limitations, health studies, on the other hand, have illustrated that an individual's social circumstances influences their health, with those in the lower ranks of society having lower life expectancy and being more prone to disease and negative health behaviours, compared to those higher up the social hierarchy (Berkman et al., 2000, Mackenbach et al., 2003, Marmot, 2005) resulting in increased health inequalities (Barnett et al., 2005, Pearce et al., 2007). There is a need, therefore, for alcohol researchers to investigate reasons for excess consumption amongst less affluent groups.

One way of understanding how neighbourhoods affect health is to first examine alcohol consumption as an outcome, which has been ignored. Few studies have focussed on alcohol consumption as an outcome variable in place research. Macintyre et al., (1993) argue that individual health-related behaviour, including alcohol consumption, has largely been relegated to a variable to control for in health outcome research, stressing the point that consumption as an outcome is equally important. There are studies that have shown that those living in areas of low SES are more likely to consume alcohol hazardously than those in affluent areas (Scribner et al., 2000). Some of the reasons for this association, researchers argue, include the fact that more alcohol outlets are located in areas of lower SES (LaVeist and Wallace, 2000, Romley et al., 2007). In addition, other scholars argue that disproportionately more marketing, including billboards and advertisements, is concentrated in such poor neighbourhoods (Alaniz, 1998). While research has shown that alcohol availability as well as advertising and marketing influence hazardous consumption, other researchers argue that there is need to go beyond description to investigating and explaining the link between alcohol availability, a contextual factor, and consumption (Gruenewald, 2007). These studies and reviews have provided ideas rather than evidence.

Ellen et al., (2001) suggested that mechanisms including investigating neighbourhood differential access to services and amenities, which may have both positive and negative impacts upon health, can also be applied to health behaviour. Additionally, there are stresses of the physical environment, stresses in the social environment, and neighbourhood based networks and norms. To this end, Macintyre et al., (1993) contend that since alcohol is more of a social problem, there is need to examine the structured contexts that constrain this choice. Macintyre et al., (1993) go further and say “whatever one's personal characteristics, the opportunity structures in the poorer area are less conducive to health or health promoting activities than in the better-off areas”. Therefore, geographers need to examine the structures that constrain or facilitate health related-behaviour. Such neighbourhood factors not only influence alcohol consumption but also health outcomes.

Based on the assumptions of Macintyre et al., (1993) and Ellen et al., (2001) and the literature on ‘obesogenic’ and smoking environments, it is important for alcohol researchers to have direct measures of the physical and social constraints in these deprived neighbourhoods such as access to alcohol outlets. Thus far, studies which have attempted to examine the relationships between access to alcohol outlets and consumption have produced inconclusive results. Huckle et al., (2008) report that in Auckland (New Zealand), the density of alcohol outlets influences drinking amongst adolescents, the greater the number of alcohol outlets in area the heavier the alcohol consumption. Similarly, Wechsler et al., (2002) and Weitzman et al., (2003a) report there is a positive link between outlet densities within the college neighbourhood and rates of heavy episodic drinking. In contrast, Paschal et al., (2007) found that the density of outlet stores was not associated with levels of alcohol consumption amongst university students. Consumption in California was actually highest amongst the least deprived (Pollack et al., 2005) and not related to access. Whilst access to alcohol outlets is an important factor, these inconsistent results call for more research and the development of theory to increase our understanding of the way in which alcohol availability in small geographic neighbourhoods influences alcohol consumption.

These inconsistencies in results may be related to study limitations in methodology and settings. First, there is little consideration of the reasons why results are consistent amongst homogenous age groups, such as university students and adolescents, and not other groups. Students are fairly well educated and most are living in their current neighbourhoods temporarily, far from their original neighbourhoods. Therefore, it is very hard to determine whether their current drinking patterns are shaped by the environment or the social structures around them. Research has failed to control for other individual factors, such as length of stay or migration status, which might influence consumption. Furthermore, the results cannot be extrapolated to other youth who may not be of the same educational level.

Secondly, most studies looking at access to alcohol have focussed on examining only one neighbourhood and outcome variable while at the same time controlling only for individual effects. Most studies examined only differential access to alcohol outlets and one outcome (LaVeist and Wallace, 2000; Pollack et al., 2005), but they did not take into account the combination of many different potential ‘place’ effects. Such limited consideration of contextual factors, either as explanatory or control variables, is a probable reason for the modest area effects observed.

Lastly, there is need to measure access to community resources accurately, since there are some variations when different methods are used. It is suggested that access studies need to use population centroids, since they take population into account and only calculates distance from the centre of the population, rather than geometric centroids, which calculate distance from the geographical centre (Pearce et al., 2006, Apparacio et al., 2008). There is a need to use consistent measures of alcohol consumption patterns instead of using different methods or proxies, such as, hospital discharge or mortality. Research also needs to consider a range of alcohol consumption behaviours.

These limitations probably explain some of the reasons for inconsistency in the relationship between access and outlets. Suffice it to note that contextual studies in New Zealand have shown different results from those observed worldwide (e.g. in New Zealand there is better access to community resources in deprived areas (Pearce et al., 2006)). Macintyre et al., (1993) argue that whatever happens in one region may not be the same in another region despite similarities in SES. Neighbourhoods have varying influences in health in different contexts. Therefore, it is important to examine the effect of contextual factors on both the whole population within an area and different sub-population separately. Research must also examine accurately measured alcohol consumption as a behavioural outcome and not a variable to adjust for in health outcome. An examination of contextual influences on consumption will no doubt shed some light on the subsequent health impacts, since these are mostly as a result of consumption patterns. Writers such as Holloway et al., (2008) and Kneale and French (2008) have emphasised the importance of understanding places where problem drinkers and drinking are produced.

1.4.2 Alcohol-related impacts

There is no doubt that alcohol consumption contributes to both positive and negative social and health outcomes. Many researchers have grappled with the consequences of alcohol with most studies concentrating on alcohol-related mortality in addition to hospitalisations and other social problems, such as drink driving and crime. Despite their efforts, Gmel et al., (2003a) suggest that such research has not fully explained behaviours that surround alcohol consumption. They suggest that such behaviours are too complex and even the health and social consequences differ across different nations and different cultures. While there are limitations in previous studies, Alaniz et al., (1998) and Parker et al., (1995), after examining evidence from criminology studies, theorised that there is some certainty that crime is committed in areas where substance abuse including alcohol consumption is taking place and is mediated by distribution of the substance being abused. While such studies are not able to relate actual consumption to crime, they use alcohol outlets as proxies for consumption. For example, in Europe and USA, there is an association between proximity to alcohol outlets and homicides, assault, prostitution and fatal traffic accidents (LaScala et al., 2001, Lipton and Gruenewald, 2002, Speer et al., 1998).

Nonetheless, whilst this relationship might be true in other contexts, there is a dearth of studies that have examined the relationship between density of alcohol outlets and crime in New Zealand. Initial studies concentrated on the relationship between individual consumption and crime (Fergusson et al., 1996, Fergusson and Horwood, 2000). The New Zealand drug Policy 2007-2012 and Law Commission chaired by Sir Geoffrey Palmer, which is charged with the responsibility of examining policy on alcohol consumption, mention excess alcohol consumption and crime as major problems that needs to be investigated. In addition, the Ministry of Justice reports that the evidence linking crime to alcohol in New Zealand is largely anecdotal, however, a significant proportion of crime is attributed to alcohol (Wood, 2005). Similarly ALAC quotes police report where one third of crimes were committed under the influence of alcohol or around areas where outlets are located. It would be therefore important to examine crime and its relationship to alcohol outlets and contextual factors.

The general understanding is that alcohol consumption can lead to crime; however, how this happens is not well understood. For example, Lipsey et al., (1997) argue that studies have failed to show how alcohol causes crime. They further add that such studies fail to show the threshold of alcohol needed to cause violence. In addition, if a certain threshold has to be reached before crime is committed then all people who reach that threshold should commit crime, rather than just a select few. As with other health studies, most researchers suggested that individual explanation does not fully explain the variation and there must be some contextual factors in play. Moreover, a recent study in New Zealand undertaken in one city suggested that the relationship between alcohol outlets and crime is context specific (Cameron et al., 2010). Alcohol outlets as well as demographics around areas where consumption takes places should be investigated, especially how they influence crime at a national level.

Similarly, for access and alcohol-related admission, many studies have shown the relationship between alcohol consumption and a range of problems on physical health. Pollack et al., (2005) have attributed alcohol outlets to consumption patterns that are suggested to result in hospitalisation. There are indications that there is a relationship between alcohol outlets (as a proxy for consumption), which are predominantly located in areas of lower SES, and hospitalisation. While not many studies worldwide or in New Zealand have examined the relationship between outlets and hospitalisation, Tatlow et al., (2000) found that the number of alcohol stores predicted alcohol-related hospitalisations. It is against this backdrop that this study intends to examine the relationship between density of alcohol outlets and hospitalisation. This study borrows from research on accessibility and density, in light of distance decay, where those living near hospitals were suggested to be more likely to use the health facilities than those living further away (Aday and Andersen, 1974). Similarly, this study intends to investigate whether density of alcohol outlets can explain hospitalisation after controlling for other individual and place variables. This analysis is important because Tatlow (2000) argue that there could be a significant reduction in the amount of money used to treat alcohol-related problems, if there is a significant decrease in alcohol outlets.

1.5 Conclusion

Geographers have shown that to understand alcohol-related behaviour and subsequent health outcomes, both individual determinants and place effects must be examined. Individual determinants have been criticised and do not completely explain the variation, and neighbourhood factors are important. Moreover, studies on health behaviour have focussed on individual factors partly because of the complex nature in addressing social and structural determinants of health and lack of theory. Research undertaken in contexts other than New Zealand has shown that there are conflicting results with some studies showing that there are place influences and others showing that there are none. Such inconsistency is because place effects are likely to be determined by characteristics of that particular place and adjusted individual characteristics (Scribner et al., 2000). Most importantly, there is no study in New Zealand that has attempted to determine the relationship between alcohol outlets as a proxy for consumption and other related outcomes such as crime. According to the theoretical assumption, it is important to examine the hypothesis that access and proximity to alcohol outlets, may offer a potential explanation for the link between neighbourhood deprivation, alcohol consumption and social outcomes including crime, in effect bringing together biological, behavioural, social and economic factors in certain places. It is against this backdrop that the objectives of the thesis are defined.

1.6 Aim

The main aim of this thesis is to determine the influence of place effects on alcohol-related behaviour and health and social outcomes in New Zealand.

The main aim will be achieved via the following objectives;

1.6.1 Objectives

- To use available proxy measures to determine the geography of alcohol consumption in New Zealand.

- To determine the variation in the geography of these proxies by age group, gender, ethnicity, rural/urban and SES.

- To develop measures of geographical access to alcohol outlets (off-license and on-license) for small areas in New Zealand.

- To determine whether access to alcohol outlets makes an independent contribution to alcohol consumption after controlling for potential confounding factors.

- To determine whether the density of alcohol outlets has an independent effect on alcohol-related hospitalisations after controlling for potential confounding factors.

- To determine whether the density of alcohol outlets has an effect on crime after controlling for potential confounding factors.

1.7 Structure of the thesis

Figure 1.2 shows the structure of the thesis and the interrelations between chapters.

The thesis has ten chapters. Following the Introduction, Chapters Two and Three examine in detail studies of alcohol consumption. The main aim of Chapter Two is to introduce the reader to research on alcohol and its effect on health. It will discuss the public health model as an overall framework for alcohol research. Each of the domains of the public health model will be considered, followed by a discussion on alcohol-related social and health outcomes including; hospitalisation, mortality and crime. Chapter Three examines individual and place influences on alcohol consumption. The main aim of the chapter is to examine how individual characteristics and contextual factors contribute to alcohol consumption and identify gaps.

After reviewing the literature, Chapter Four focuses on the data and the methods used to address the main aim of the thesis. This chapter explains all the data to be used for the different aims as well as the different methodologies used. Chapter Five examines the geography of consumption using the two proxies, hospitalisation and mortality. And for the two proxies, an examination of factors that contribute to geographical variation namely age, gender, ethnicity, urban/rural, and area level SES. Furthermore, more details in the temporal and spatial variations of alcohol-related mortality and hospitalisation, used here as proxies of consumption, will be presented. This chapter will conclude by identifying which of the two measures is a better proxy.

Chapter Six examines results of developed alcohol outlet access measures with specific interest in geographic distribution of alcohol outlets and how access relates to deprivation regionally, in urban and rural communities, as well as across the whole of NZ.

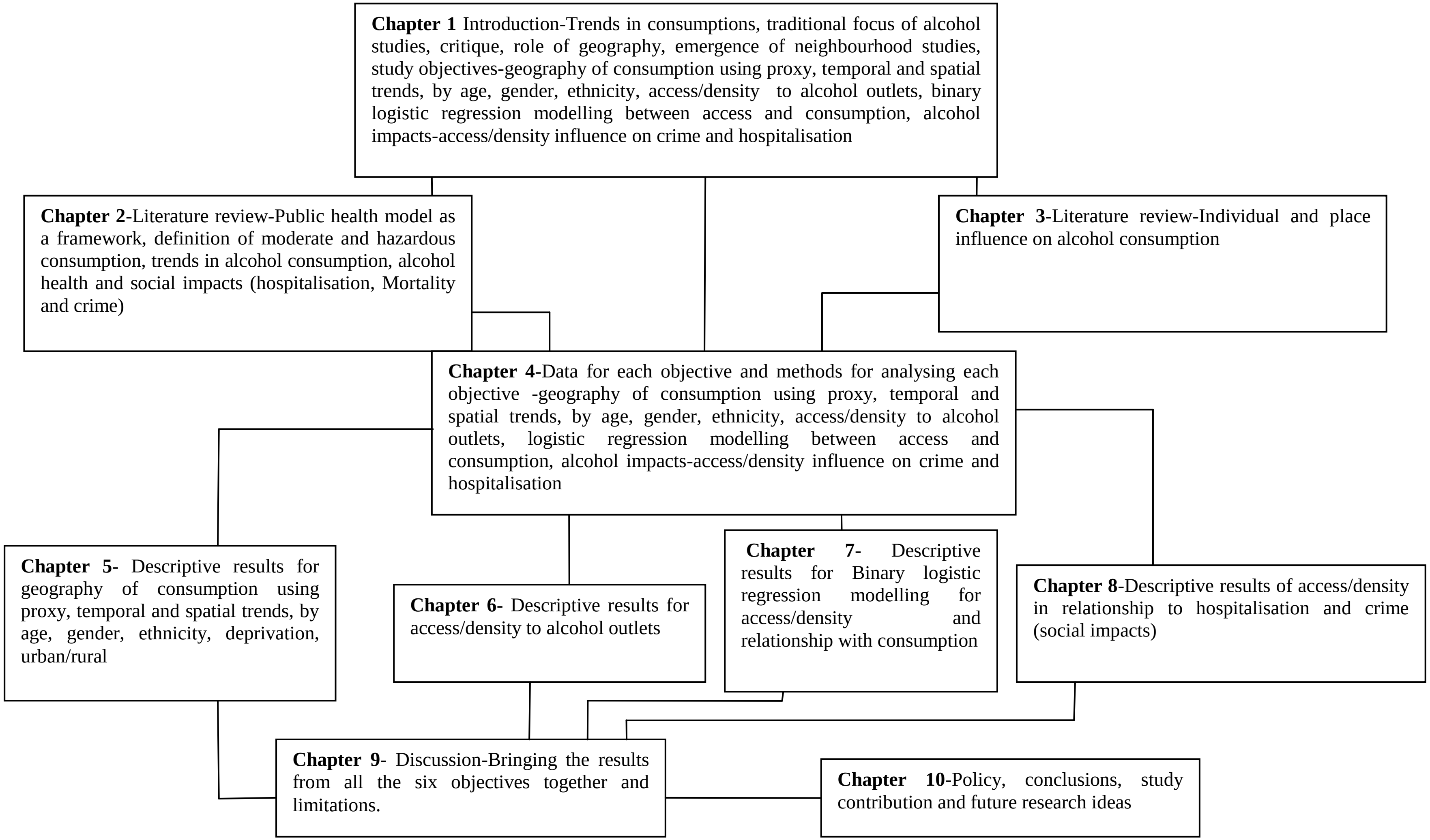
Chapter Seven examines the relationship between access and density of alcohol outlets and alcohol consumption. Binary logistic regression modelling will be used to establish whether the area measures of alcohol outlet accessibility has an independent effect on hazardous and frequent alcohol consumption for individuals in the New Zealand Health Survey after controlling for other potential confounding factors. This chapter discusses the association between different access measures and different consumption measures.

Chapter Eight examines the relationship between access/density of alcohol outlets and two social impacts, namely hospitalisations and crime. This chapter focuses on density of alcohol outlets and health outcome and social outcomes at a broader CAU and TA level.

Chapter Nine draws together all the key findings of the results to explain the meaning of the results, with specific emphasis on the relationship between access and consumption and study limitations.

Chapter Ten will then focus on final conclusions, study contributions, policy issues of the study before making some recommendations for future studies.

Figure 1.2: Structure of the thesis



Chapter 2 Alcohol consumption and health outcomes: A review

This chapter examines the epidemiology of alcohol consumption and health outcomes and discusses the Public Health Model as an overall framework which covers both individual and environmental domains. Definitions of moderate and hazardous consumption are provided and the influences of each of these upon health outcomes are considered. Current world alcohol consumption trends are discussed along with health outcomes and both protective and risk factors. Trends in alcohol-related hospitalisation and mortality will be discussed as well as probable reasons for these trends. The impacts of different consumption patterns of alcohol on crime are also outlined.

2.1 Alcohol Epidemiology: Introduction

Alcohol use is a major concern to many public health specialists and health researchers (Clapp et al., 2001). In common with other health research, the focus is shifting from individual to environmental factors. Initial population research in alcohol-related epidemiology focused on individual consumption patterns, specifically on those socio-demographic characteristics and psychological variables that contributed to excess alcohol consumption. However, within the last four decades, there has been a shift towards examining environmental and ecological explanations of alcohol consumption (Harford et al., 1979). It is now recognised that there are environmental contributions which lead to increases in hazardous or harmful consumption and specific problems associated with such trends. The previous narrow focus of blaming the individual has given way to a broader focus on environmental and social contexts. Macintyre et al., (1993) state that it is important to investigate both individuals and their broader context since isolating one results in an inaccurate estimation of the phenomenon as each factor influences the other. Despite environmental explanations in health becoming increasingly popular in the 1970s, not many researchers, geographers included, engaged with environmental influences on alcohol consumption (Jayne et al., 2008). Clapp et al., (2001) add that environmental evidence in alcohol research is thin.

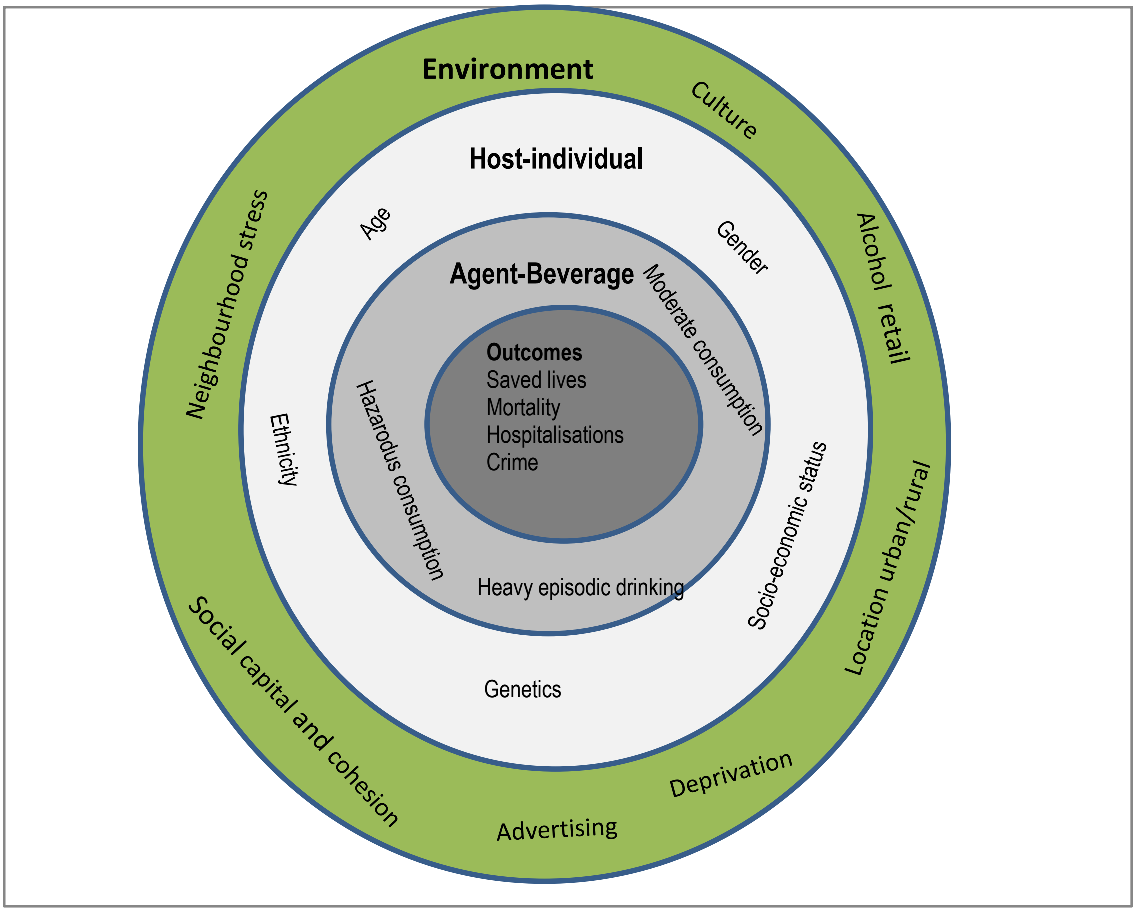
Alcohol consumption patterns influence health outcomes, and are mediated by the environment where people live. Consequently, biological, behavioural, social, cultural and economic factors are potentially important to any conceptual model of alcohol use and subsequent outcomes. One model suggested to incorporate these variables is the Public Health Model (Clapp et al., 2001).

2.2 The Public Health Model

The Public Health Model traces its origin from studies of disease. Public health researchers suggest that disease transmission is multi-factorial, indicating an interaction between biological, behavioural, social, cultural and economic factors. This theory was adopted by substance use and abuse researchers, who emphasised the importance of an ‘agent’ (substance or beverage), a ‘host’ (individual characteristics and behaviour) and the environment (with its social, economic and physical characteristics) as variables explaining the complex nature of substance use and abuse. The Public Health Model is therefore valid in explaining the link between alcohol consumption patterns and subsequent alcohol-related outcomes (Clapp et al., 2001). Figure 2.1 illustrates the conceptualised association between the different domains (Clapp et al., 2001). The outer layer, the environment, has many factors that influence the individual in the next layer. Following the individual or ‘host’, the next layer is the ‘agent’ or beverage consumed and depending on consumption patterns this confers both beneficial (e.g. reduced risk for cardiovascular disease (Gunzerath et al., 2004, Niroomand, 2004)) or adverse health (e.g. intoxication and injury (Christie, 2008, Jones et al., 2008)) and social outcomes (e.g. crime (Groman et el., 2001, Scribner et al., 1995). Each of the layers is considered separately.

Starting with the third layer, the ‘agent’ or alcohol beverage, may be beer, wine or spirits (Clapp et al., 2001). In some societies there are traditional brews (e.g. homemade Vodka in Russia and ‘changaa,’ a distilled drink in Kenya) (WHO, 2004), whose alcohol content is unknown. Most important is the amount of beverage consumed. Clearly, consumption patterns may lead to either negative or good health outcomes depending upon the level of consumption. Factors affecting consumption levels include price, advertising and availability. Many studies have classified these variables as being part of the environment. Of particular interest is how the beverage is consumed by the individual and the factors that influence such behaviour as highlighted in Figure 2.1.

Figure 2.1: Public Health Model: Conceptual model of the interaction between host and agent within an environment and the health and social outcomes based on the consumption pattern



An individual or 'host', the second layer in the conceptual model, has several attributes that are associated with alcohol consumption. These attributes are biological, psychological and socio-demographic characteristics (Clapp et al., 2001). Biological factors include the inheritance of genes that make someone prone to alcohol consumption, if one parent was a consumer. The psychological factors include people's reasons for drinking, such as attitudes, beliefs, coping skills, risk taking, 'masculinity', depression and self esteem. Demographic factors include age, gender, race, ethnicity and socio-economic status which are traditionally suggested to influence alcohol consumption. Whilst these factors are important on their own, they should not be viewed in isolation since they interact with each other in different ways. For instance, psychological variables can be examined to explain the differences in demographic characteristics of alcohol consumers (e.g. adolescents consume alcohol in order to cope better with their peers and to enhance their self esteem). Pape and Hammer (1996) argue that this list should also include historical use of alcohol as one domain because age at first use is a good determinant of current or future alcohol use. Research is inconclusive, however, as to whether this relationship is true for all cases. Despite the explanatory power of the individual or 'host' in the Public Health Model, and because of multi-factorial nature of alcohol consumption, Macintyre et al., (1993) argue that individual studies have never fully explained the prevalence of consumption. Jayne et al., (2008) add that investigating the 'host' alone does not explain geographical differences and that the 'host' must also be examined in relation to the environment where the actual consumption takes place.

The environment is the outer layer in the conceptual model and has been defined in several ways. For alcohol researchers, it has been defined as representing drinking contexts. These are social, temporal and physical characteristics of drinking events which include the composition of the group which is drinking, where the drinking is taking place and also the availability of alcohol (Clapp and Segars, 1993, Smith and Hanham, 1982). Other researchers have defined the environment as the contextual factors that facilitate or inhibit alcohol consumption. These include psychosocial factors, stress, area socioeconomic status, alcohol availability, advertising and cultural influences (Clapp and Segars, 1993, Ecob and Macintyre, 2000). Such researchers suggest there are combinations of factors that would offer both protective as well as risk factors for alcohol consumption.

The model suggests that it is a combination of the 'agent', 'host' and 'environment' that eventually leads to a choice of either hazardous or moderate alcohol consumption. However, most researchers are still not clear on why and how this happens. What is not in dispute is that alcohol-related outcomes including mortality and hospitalisation rates as well as health benefits all depend upon the amount of alcohol consumed. The model has limitations. For example, Gruenewald et al., (1997) argue that the Public Health Model fails to provide an explanation on how 'host', 'agent' or 'environment' are chosen as variables, specifically calling for a definition of the selection criteria. Despite this limitation, behavioural researchers contend that the Public Health Model offers a good framework for explaining alcohol consumption patterns (Clapp et al., 2001). While this is examined further in following sections it is important to first understand the different consumption patterns and examine how they fit into the Public Health Model.

2.2.1 Definition of consumption patterns

Alcohol consumption patterns can be defined in three ways: Moderate (offering protection), heavy episodic (National Institute on Alcohol Abuse and Alcoholism, NIAAA 1996), and hazardous (risk taking) (Edwards et al., 1978).

According to the USA Department of Health and Human Services/USA Department of Agriculture Dietary Guidelines (NIAAA) 1996), moderate consumption is defined as one drink a day for women, and two drinks a day for men, measured as; 12 oz of beer, 5 oz of wine, or 1.5 oz of spirits. This equates to approximately 0.6 grams of ethanol. Heavy episodic drinking, also considered hazardous, has different definitions in different countries. Researchers have quantified a threshold that is safe or unsafe, depending on the amount and the time taken to consume it. While different countries have different measurements, the most commonly used definition comes from the NIAAA (1996) in the USA, which defines heavy episodic drinking as "drinking alcohol that brings blood alcohol concentration (BAC) to 0.08 g per cent or above". This means, for a typical adult, a level which corresponds to consuming five or more drinks (male), or four or more drinks (female), in about two hours. It has been suggested that body weight, alcohol tolerance and also whether or not food was consumed before drinking should all be taken into consideration (Kypri et al., 2005a).

Hazardous drinking is defined as drinking that confers the risk of dysfunction or harmful consequences (Edwards et al., 1978). This equates to someone who typically drinks more than five drinks within two hours and does this frequently. In most cases heavy episodic drinking is also classified as hazardous drinking. The WHO, however, uses AUDIT to measure hazardous consumption and incorporates quantity and frequency as well as the effects of drinking as some of the variables. A score of eight or more , with a maximum of 16, is then used to classify hazardous consumers (Babor et al., 2001).

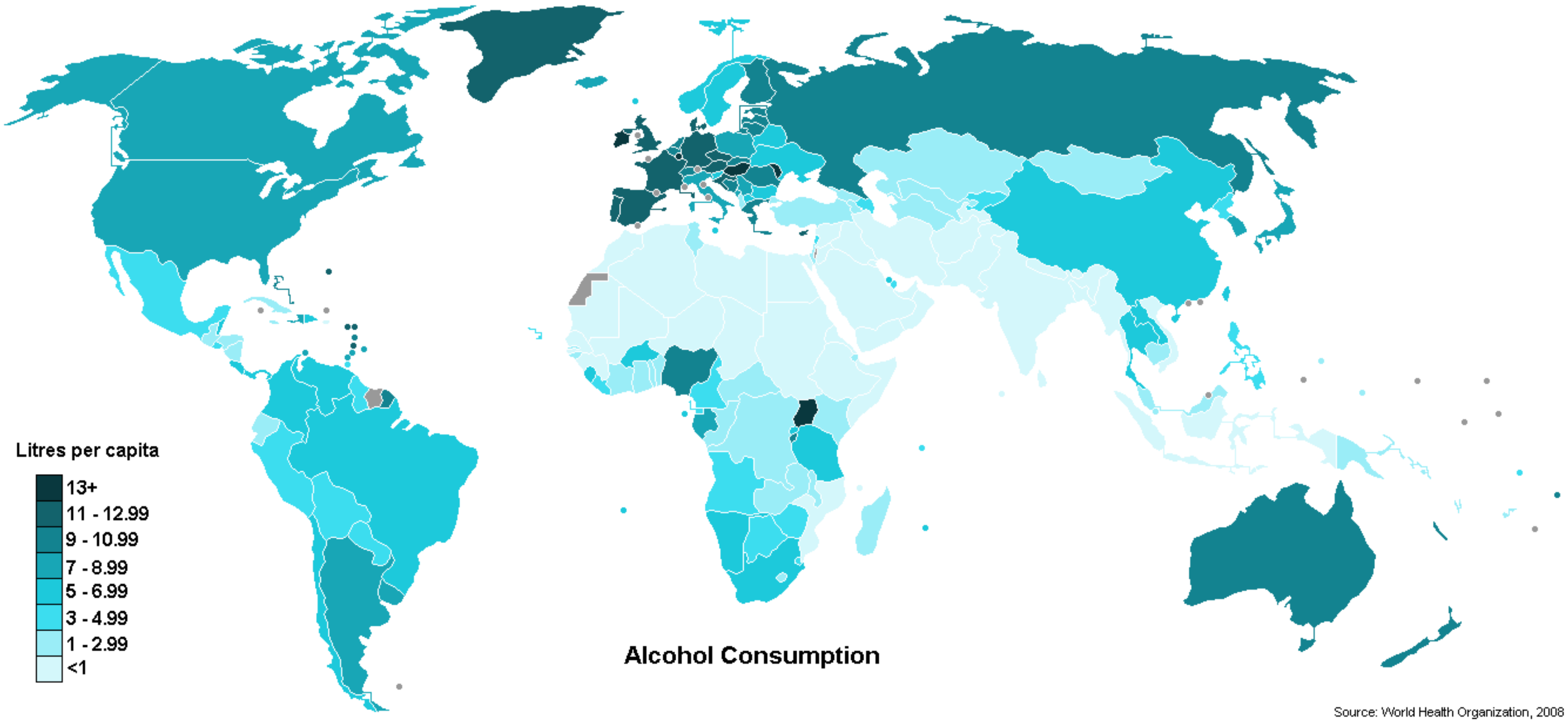
These drinking patterns are associated with biological functions that cause good or bad health. Moderate consumption has health benefits, such as the reduction of coronary heart disease (Gunzerath et al., 2004), while hazardous consumption can lead to dependency or intoxication and bad health (Rehm et al., 2007).

2.3 Trends in alcohol consumption

Recent alcohol-related consumption trends have shown interesting patterns. First, at a broad level, consumption patterns are higher in wealthier than in poor nations. Secondly, while there has been a reduction in consumption worldwide, there has been an increase in the number of people consuming alcohol hazardously. Thirdly, men aged 15-24 and women aged 15-29 have disproportionately contributed to this increase in hazardous consumption.

A review of consumption patterns by the WHO in 2007 shows that per capita consumption is higher in wealthier countries than in relatively poorer nations. A select analysis of WHO countries shows that Luxembourg, one of the wealthiest nations in the world, has a per capita consumption of 15.6 litres of alcohol followed by Ireland at 13.5 litres per capita. New Zealand is ranked 24th at 9.7 litres per capita and is six places higher than Australia which is ranked 30th at 9.0 litres per person (WHO, 2007). Similar results were reported in 2008; see Figure 2.2 which illustrates that most poor and developing nations have a lower per capita consumption when compared to the rich OECD countries. However, these trends need to be treated with caution since there are shortcomings in per capita consumption research. Consumption is measured in a variety of ways including total sales, alcohol-related tax revenues and total alcohol production, excluding exports. Per capita consumption figures may mask heavy episodic drinking, especially in countries where only a few people are heavy episodic consumers. Per capita consumption, however, is important in public health as it can identify countries with heavy consumption and highlights the potential for negative health consequences (WHO, 2007).

Figure 2.2: World per capita litres of alcohol consumption



At an individual country level, researchers have relied on surveys to separate the different consumption patterns relating to abstainers, moderate consumers and heavy episodic or hazardous consumers. One trend that has been illuminated in England, Australia, Germany and USA in the worldwide surveys has been a decrease in overall consumption but an in increase in hazardous consumption. This trend affects both genders, although men generally consume more alcohol than women. Men are more likely to drink more frequently and more hazardously, no matter where they live (WHO, 2007), with estimated consumption of 29 standard drinks in a week. Historically, this pattern of hazardous drinking has been more prevalent in males and has been traditionally explained by 'masculinity'. Masculinity theory is disputed, with arguments that recent increases in consumption of beer and spirits as opposed to wine are to blame (World drinking trends, 2005). Most surveys also indicate that there has been a significant increase in consumption among women (WHO, 2007, World drinking trends, 2005, WHO, 2004). This has been attributed to increased workforce participation as well as alcohol manufacturers producing new products such as alcopops and light beer which have increasingly appealed to women. World Drinking Trends (2005) reports that in the UK growth in the consumption of rosé and sparkling wine is significant because of women's increased consumption. There is a greater tendency for women to consume wine at home or in the restaurant often at a rate of more than 16 standard drinks a week, indicating heavy episodic or hazardous consumption.

This increase in women's consumption has been most prevalent in the 14–29 year age group. Studies in New Zealand and United Kingdom, for example, show that those aged 14 years have begun consuming alcohol even though they are 'under age'. Since young women may not access licensed premises they rely on their parents (Kypri et al., 2007) or older friends to purchase alcohol for them (Clark, 2007). In addition, advertising and marketing target young women to increase their consumption with trendy and 'eye catching' strategies (McCreanor et al., 2008). While alcohol supplied by parents is likely to be moderated, this is unlikely to be the case for friends, who, as suppliers may be considered contributors to the increase in heavy episodic drinking. The WHO reports that, for both girls and boys, there has been a significant upward trend in heavy episodic drinking with 15–29 year olds more likely to have higher rates of current and heavy episodic drinking than older adults. Hibbell (2003) report that for the very young (15–16 years old), the highest percentages in heavy episodic drinking are reported in Ireland (32%), the Netherlands (28%), United Kingdom (UK) (27 percent), Malta (25%) and Sweden (25%). In a subsequent study, for same age group, Hibbell et al., (2009) found that Portugal recorded a significant increase (from 25% to 56%) between 2003 and 2007 along with other countries such as Poland (16%), France (15%), Croatia (14%) and Bulgaria (12%). Similarly, in a majority of the EU Member States, heavy episodic drinking amongst girls increased from 35% to 42% between 2003 and 2007. In the USA, an analysis of the Behavioural Risk Factor Surveillance System (BRFSS) from 1993-2001 showed that although there was a significant increase in heavy episodic drinking amongst the youngest age groups, the adult population also recorded an increase. For example, heavy episodic drinking for 18-26 age group increased by 56%, but only 25% for the 26-55 age group (Naimi et al., 2003). This increase in heavy episodic drinking both in Europe and the USA has been attributed to choice of beverage (e.g. wine, alcopops) and different cultures (e.g. English culture of beer drinking) of consumption.

Bjarnason et al., (2003) argue that because of differences in beliefs and attitudes across cultures on alcohol, consumption trends have been defined based on the amount and the type of beverage consumed. These differences are sometimes also related to geographic location. For example, differences in consumption between Northern and Southern Europe or between north-central, western USA and south-eastern USA (Naimi et al., 2003) are sometimes related to different consumption cultures and whether areas were ‘dry’ or ‘wet’. “Wet’ areas are characterised by heavy consumption. Countries characterised by their most common consumption patterns include the traditional moderate wine consumers in Southern Europe, such as France, Spain, Italy, Portugal and Greece. Recently, changes have been observed in these countries with evidence of an increase in heavy episodic drinking for the younger age group (15–24 years). Similarly, low alcohol consumption countries such as Sweden and Norway, traditionally had the highest number of abstainers and a low per capita consumption but are now characterised by heavy episodic drinking. Northern and Eastern European states are consumers of beer and spirits, which have traditionally been drunk in larger quantities than the wine of Southern Europe. England has high per capita consumption specifically due to large numbers of people who indulge in heavy episodic drinking. On the other hand, Eastern European countries have cultures of hard spirit consumption (Popova et al., 2007).

Historically the change in traditional cultural drinking patterns has been associated with social changes and changes in the beverage consumed. For instance, wine consumers in France are adopting the British culture of beer consumption (Nahoum-Grappe, 1995). With the emergence of new cultures, new ‘modern’ lifestyle and values are associated with new drinks (Hupkens et al., 1993), such as alcopops and sweet wine (WHO 2004, 2007). Such changes have resulted in an increase in hazardous consumption and adverse health and social outcomes.

Despite such emerging cultures, what is consistent is that alcohol is always consumed in a certain environment with each ‘culture’ creating its own unique drinking place. Such drinking places are replete with their own sets of laws, customs and values (Social Issues Research Centre, 1998). The ‘environment’ where drinking takes place, is therefore important in understanding both moderate and hazardous consumption, and subsequent health and social outcomes (Kneale and French, 2008).

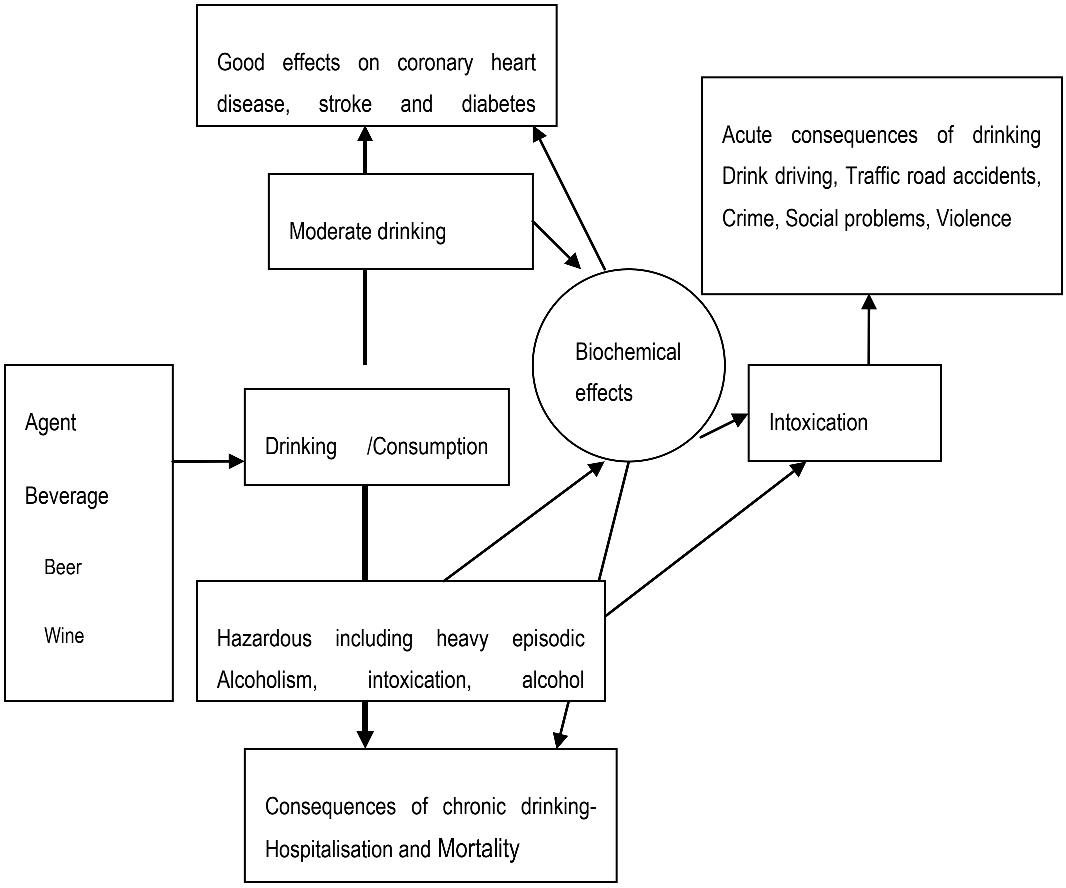
2.4 Health outcomes

2.4.1 Introduction

This section examines the impact of alcohol consumption on health, both the negative and positive impacts (Figure 2.3). First, the biological and chemical effects of alcohol on the body are defined. The following discussion of the health impacts covers the benefits of moderate consumption as well as the adverse impacts of heavier drinking on both mortality and hospitalisation rates and on social behaviours, such as crime.

Alcohol has a biochemical effect that leads to intoxication and dependency, especially at higher levels of consumption (Figure 2.3). Those who drink moderately may experience some health benefits while those who drink hazardously may suffer from a variety of diseases. For example, moderate consumption reduces plaque deposits in arteries thereby helping to prevent coronary heart disease (CHD) (Gunzerath et al., 2004). On the other hand, hazardous consumption increases risk of high blood pressure and will have a toxic effect on acinar cells activating pancreatic damage (Apte et al., 1997).

Figure 2.3: Hypothesised pathways for agent on alcohol-related behaviour and outcomes



Intoxication occurs because alcohol (ethanol) is a substance with addictive potential as it enhances activity in the brain's reward system by increasing the release of the beta-endorphins, thus leading to alcohol-induced euphoria. The reason the quantity of alcohol consumed exceeds the body's tolerance level and impairs one's mental and physical ability is because alcohol increases the effect of the body's naturally occurring neurotransmitter GABA (gamma-aminobutyric acid). Neurotransmitters are substances that chemically connect the signals from one nerve to the next allowing a signal to flow along a neural pathway. An inhibitory neurotransmitter, such as alcohol reduces this signal flow in the brain, which explains why alcohol depresses both a person's mental and physical activities (WHO, 2004).

Alcohol dependence is described by the WHO as "a cluster of physiological, behavioural and cognitive phenomena in which the use of alcohol takes on a much higher priority for a given individual than other behaviours that once had greater value" (WHO, 2004, p. 5). Typically, these phenomena include a strong desire to consume alcohol and a higher priority being given to drinking than to other activities and obligations. In addition, dependence is associated with increased alcohol tolerance and a physical withdrawal reaction when alcohol use is discontinued.

The paths to intoxication or dependence are varied and range from individual factors to socio-environmental factors as explained in the Public Health Model (WHO, 1993). Biological functions are normally associated with individual determinants, especially the amount of alcohol consumed, without necessarily examining the environmental factors that facilitate such consumption. Biological factors are important in illuminating how alcohol causes disease in a human being, but recent studies have begun to suggest that these effects are influenced by the environment in which one lives (Macintyre et al., 2002). There is evidence that the amount of alcohol consumed contributes to both mortality and hospitalisation rates, although moderate consumption may have health benefits.

2.4.2 Protective Factors

2.4.2.1 Moderate consumption and health

Moderate consumption may be a protective factor for CHD, as it reduces plaque deposits in arteries and other forms of cardiovascular disease particularly in middle-aged and older men and post-menopausal women thus contributing to a reduction in mortality (Gunzerath et al., 2004). These protective effects apply only to those who regular drink up to 30 grams of alcohol per day (Gunzerath et al., 2004). For people who have already been diagnosed with CHD, moderate drinking may decrease the risk of disease progression and any future cardiovascular events (Niroomand, 2004).

Rimm et al., (1991) argue that there is an inverse relationship between moderate alcohol consumption and CHD. This is true of studies undertaken in different cultures, which were different in terms of population, size, and length of follow up. Research undertaken in France, Japan, Denmark, Germany, Finland, Korea, Great Britain, and the USA indicated that there are health benefits in moderate alcohol consumption (Rimm et al., 1991).

It has been queried whether these benefits apply only to older age groups. Epidemiologists have subsequently examined the relationship between CHD and alcohol consumption by focussing on subgroups, including both the older and middle-aged population. Results have indicated that moderate alcohol consumption provides benefits to the older population where CHD is normally highest, however, middle-aged people also benefit from moderate consumption because of the aetiology of CHD (Fuchs et al., 1995). Further analysis of other risk factors for CHD, including the prevalence of diabetes and obesity, also showed an inverse association with alcohol consumption (Beulens et al., 2005, Conigrave et al., 2001, Koppes et al., 2005, Wannamethee and Shaper, 1999, Wannamethee et al., 2002, Wannamethee et al., 2003, Wannamethee et al., 2004), indicating that moderate consumption benefits a wide array of population subgroups. Other commentators have argued that lifestyle or the type of beverage consumed could be confounding factors. Curtis Ellison & Martinic (2006) found in a study comparing France (wine drinking), Germany (beer) and Japan (spirits) that there were no differences related to the choice of alcoholic beverage and CHD. Renaud et al., (2004) demonstrated that moderate alcohol consumption, of whatever type, had a consistent inverse association with CHD, although wine was said to be slightly more beneficial in its health impacts.

Moderate alcohol consumption also contributes to a reduction in mortality. It is estimated that there would be approximately 80 000 more deaths per year if all drinkers in the USA became abstainers (Gunzerath et al., 2004). This shows that abstaining dramatically increases the risks of heart attack, ischaemic stroke, and many other diseases and life-threatening conditions In England and Wales, light and moderate drinking saves more lives than are lost. For example, one study found that the moderate use of alcohol led to a net gain of 1864 lives (Britton and McPherson, 2001).

In New Zealand, a case-control study examined the risks of alcohol consumption in CHD in Auckland (Wells et al., 2004). The results showed some benefits in moderate consumption for CHD for both men and women in middle and older ages. In 35–74 year old men, there was a strong protective association between moderate alcohol consumption and coronary heart disease. In contrast protective effects for women were seen only in the light-to-moderate drinkers, and the scale of the protective association was smaller. Furthermore, a national study undertaken in New Zealand had similar results while using the comparative risk assessment (CRA) methodology (ALAC, 2005). This methodology was developed by the WHO for measuring the impact of important risk factors on health at a regional and global level. The CRA approach was used at national level and for Māori and non-Māori separately where possible. People who consumed moderate amounts of alcohol were protected from ischaemic heart disease, one of the highest causes of death in New Zealand, as well as stroke and diabetes mellitus. However, this benefit was evident only for non-Māori. Possible explanations could be that Māori indulge in heavy episodic drinking or suffer from some other confounding risk factors (ALAC, 2005).

Moderate alcohol consumption, therefore, offers some benefits to people of different age groups and different ethnic backgrounds depending on consumption patterns. It is worth noting that research has made significant strides in understanding the relationship between moderate drinking and health outcomes. One important limitation is that epidemiological research rarely takes psychosocial factors, such as social cohesion or group norms, into consideration. Normally, this is because such factors are very hard to measure yet these are important factors in understanding moderate alcohol consumption, hence they should be viewed as part of the social, cultural and lifestyle issues rather than being studied in isolation (Curtis, 2004).

2.4.3 Risk Factors

There are risk factors associated with hazardous alcohol consumption and these include alcohol-related hospitalisation and mortality as well as social problems such as crime. There are other social problems such as losing friends, potential job loss, child abuse, separation of family members and divorce, however these are not discussed in detail here.

2.4.3.1 Alcohol-related hospitalisation

It is widely accepted that heavy episodic drinking is associated with alcohol-related harm and can cause a myriad of diseases and health problems including psychoses, cardiomyopathy, liver cirrhosis, stroke and other cardiovascular problems, pancreatitis, neurological damage, toxic effects, alcohol poisoning and low birth weight for unborn babies (WHO, 2002). These have all resulted in increased rates of hospitalisation. The main themes arising from research in this area are that patterns of hospitalisation are impacted by the type of alcohol-related disease or health issue, (eg. intoxication, pancreatitis) and by socio-demographic factors such as age, gender, location, ethnicity and socio-economic status.

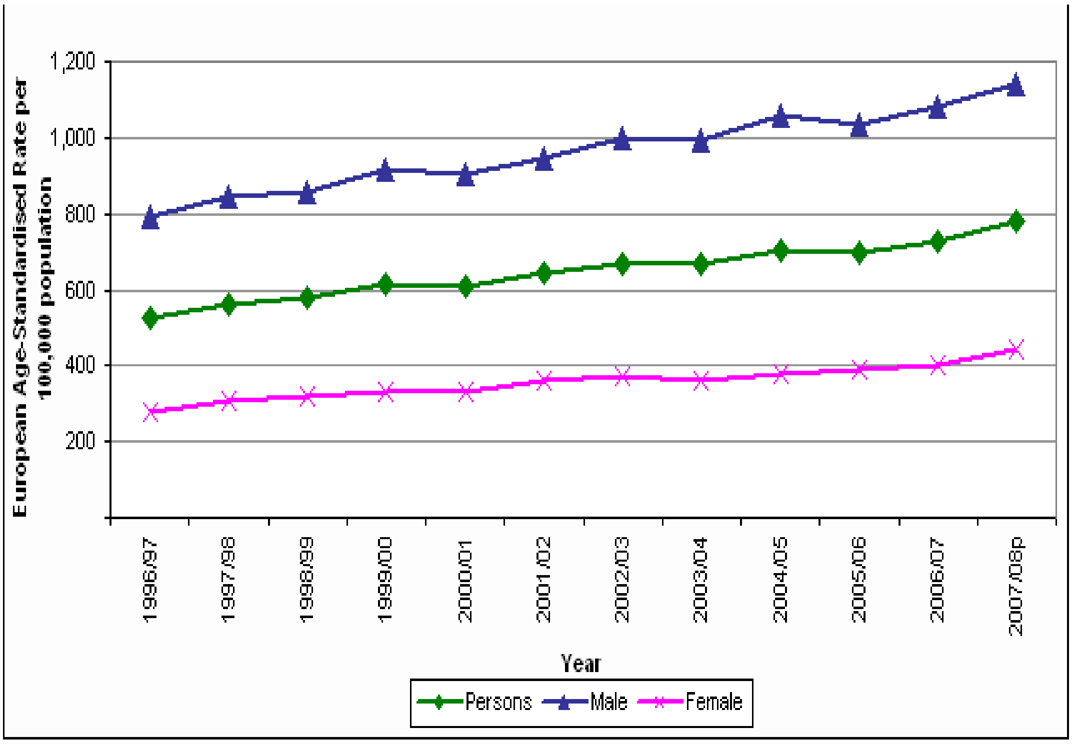
In recent years, the media in the UK and New Zealand have reported that alcohol-related hospitalisations caused by hazardous consumption are on the increase and in some cases have doubled within the last 10 years (Thomas, 2009, Tulip, 2009).

> **“***Young people should not be coming to the Emergency Department, this stuff is preventable and it is very frustrating when you have people with heart pains or serious respiratory problems having to wait because staff have to deal with teenagers with broken wrists or been in a fight because of being drunk” Dr Paul Quigley, Emergency department, Wellington (Kim Thomas, 22/08/2009, The Christchurch Press)*

The above excerpt is typical of reports found regularly in New Zealand newspapers. As a consequence there is growing concern about the impact of such admissions on hospitals and their staff. Normally there are two types of patients; those who come in with minor problems such as intoxication and those who have major problems such as liver cirrhosis. Those with minor problems are sometimes treated as an emergency and discharged, or admitted for overnight observation, while those with more serious problems stay much longer.

In recent years, alcohol-related hospitalisations have tripled in Scotland. Scottish government statistics show that rates of hospitalisation increased from slightly less than 250 per 100 000 in 1996/1997 to 777 per 100 000 in 2007/2008 (Figure 2.4) (Scottish Government Statistics, 2009).

Figure 2.4: Alcohol-related hospitalisations 1996/97 to 2007/08



Source: NHS Information Services Division (ISD Scotland) (SMR01)

The WHO has attributed this rise in rates of hospitalisation to increased hazardous consumption amongst groups of different socio-demographic characteristics. Recent changes in the youth drinking culture now mean that youth drink to get drunk rather than to socialise. In New Zealand, the Christchurch newspaper "The Press" reports that 5400 people aged 15–24 years were hospitalised between 2002 and 2006. Of these, 11% were diagnosed as intoxicated (Thomas, 2009). The proportions are similar in Scotland and England where most people who consume alcohol hazardously end up in hospital. Christie (2008) reported that in Scotland, 15 young people attended hospital every day for alcohol-related injuries or illness, mostly after consuming more than 13 units of alcohol. In England, because of heavy episodic drinking, over 35 000 people aged 16-24 (mostly male) were admitted to hospital for alcohol-related illnesses with the number of admissions increasing with age (Jones et al., 2008). The trends in England and Scotland reflect heavy episodic drinking. However, European countries that are normally considered to be moderate consumers on average have also reported significant increases in intoxication-related hospital treatment. In the Netherlands, because of an increase in number of people who drink to intoxication, the rates of young people aged 10–15 years who sought treatment in hospital in 2005 were six times higher than in 2001. In addition, there was a also a significant increase for those aged 15 and above (Valkenberg et al., 2007), calling for further explanation in this sudden increase.

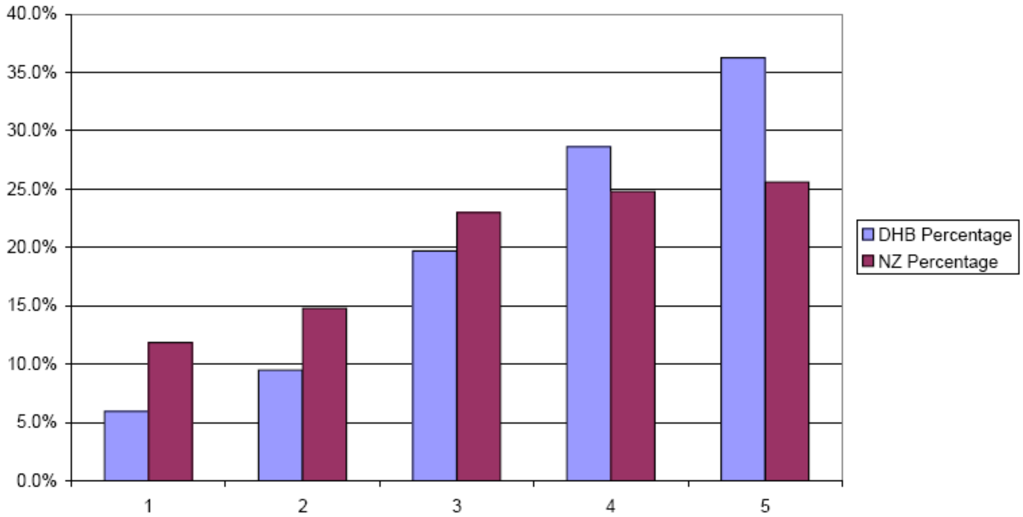
Most surveys have noted an increase in consumption for both the younger age groups and more specifically for women since the 1990's. Significantly, studies have noted an increase in consumption rates for women who traditionally have consumed little alcohol. Consequently, hospital use has risen. This is especially the case for alcohol-related diseases which were once found among older people and which are now found amongst younger or middle-aged people, particularly women. Pancreatitis, a disease related to intoxication is now fairly common amongst these age groups. In Ireland, between 1997 and 2004, there was a significant rise in the rates of pancreatitis in the 30-49 age groups. Within the same period, Irish women in the 20-29 age group showed a 10-fold increase in pancreatitis (O'Farrell et al., 2007). This was associated with higher alcohol consumption rates amongst women beginning in the 1990's. Countries with low per capita alcohol consumption but heavy episodic drinking, such as Finland, have also reported a notable increase in pancreatitis hospitalisation. In Finland, the pancreatitis hospitalisation rates increased from 57 to 69 per 100 000 for men and for women the rates rose from 7 to 12 per 100 000 between 1970 and 1989 (Sand et al., 2009). The Finnish rates were slightly lower than the Irish rates. This difference may be explained in part by the fact that women's increased alcohol consumption is a phenomenon of the 1990's (WHO, 2004) which period was excluded from the Finnish figures.

Some commentators suggest that the differences are also explained by differences in contextual and cultural factors in each country. Overall, the general trend has been an increase in pancreatitis especially in countries where heavy episodic drinking is prevalent, such as England, where between 1990 and 2000, hospitalisations for age-standardized acute pancreatitis rose by 43%, whilst those for chronic pancreatitis rose by 100% (Tinto et al., 2002). While the rise in Ireland examined earlier, is attributed mostly to increased alcoholic consumption, in England poverty has been identified as a contributor to the increase in alcohol consumption and subsequently hospitalisation. Poor areas had relatively higher rates compared to affluent areas. Female alcohol-related hospitalisations varied from 420 per 100 000 in Northwest England to 970 per 100 000 in Eden in Liverpool (Jones et al., 2008), showing a difference in female hospitalisation rates even between relatively poor areas. It is suggested that because of the stress of their economic situation, those living in less affluent areas tend to consume more alcohol and are therefore at greater risk of alcohol-related disease. Additionally, there is a high density of alcohol outlets in such poor areas, making alcohol readily available. As noted above the rates of alcohol-related hospitalisation differ significantly amongst the poorer areas. In England there are differences in areas with high rates such as the Northeast (1100 men per 100 000) and the Northwest (536 men per 100 000). These rates were comparatively higher than average rates in England (340 men and 164 women per 100 000) in 2005/2006 (Jones et al., 2008). These dissimilarities show that each area is unique and research needs to unpack the contextual differences that underlie such variations.

Further analysis of government statistics in the UK show that the most deprived areas such as Liverpool, Manchester and Middlesborough had over 1400 men per 100 000 admitted to hospital for alcohol-related diseases. This is approximately 70% higher than the average for England (Department of Health, 2009). In New Zealand, a report from Counties-Manakau shows that alcohol-related hospitalisations are higher in areas of lower socio-economic status. It is estimated that between 2001 and 2005 alcohol-related hospitalisations for young people aged 15–24 years were 2.7 times higher for those living in the most deprived areas (decile 10), compared to those living in the most affluent (decile 1) areas (Craig and Jackson, 2006). (Deciles and quintiles are used to denote area-level socio-economic status with one showing the least deprived and 10 (deciles) or five (quintiles) showing the most deprived.) Similarly, in Waikato, those in quintiles four and five had higher than the average New Zealand rates of alcohol-related hospitalisation (Waikato District Health Board, 2005) showing that even within New Zealand there are differences (See Figure 2.5).

Other differences in hospitalisation are manifested between ethnic groups. Minority ethnic group tend to use the hospital more than mainstream groups for alcohol-related admissions. For example, in New Zealand in Waikato, more Māori than non-Māori were hospitalised between 1997 and 2003 (Waikato District Health Board, 2005). Craig and Jackson (2006) also reported similar results for youth in the Counties

Figure 2.5: Alcohol-related hospitalisation in Waikato DHB by quintile



Deprivation quintiles

Source: Waikato District Health Board (2005)

Manukau District Health Board area, with Māori alcohol-related admission rates being 2.1 times higher than those of Europeans.

Recent newspaper reports have also highlighted that Māori in Canterbury are two times more likely to be admitted than the national average (108 compared to 45 per 100 000) for alcohol- and drug-related disorders (Sachdeva, 2010). Within these ethnic disparities there were also differences related to age with those most likely to be admitted being Māori aged 15–19 or over 30. However, for non-Māori the highest rates of hospitalisation were for those in the 15–19 age groups.

One major cause of hospitalisation is alcohol-related injury. In New Zealand maxillofacial injuries (around the upper jaw and face) are on the increase. In Waikato, as in the 2010 Christchurch newspaper report cited above, this is mostly as a result of injuries sustained during a fight after drinking, usually by middle-aged males (Waikato District Health Board, 2005) of minority ethnic groups. A study in Christchurch reported similar findings over two periods within 11 years (Lee, 2009). Alcohol use is also associated with an increase in injuries for a variety of road users (Eckhardt et al., 1998, Gmel et al., 2003b).

The impact of socio-demographic characteristics on alcohol-related issues and diseases is further compounded by location of residence. While men generally have higher hospitalisation rates than women this is not always the case. Male hospitalisation rates for alcohol-related issues in Victoria, Australia, were higher for rural than urban men (Hanlin et al., 2000). Alcohol poisoning is also higher in rural areas of the Belarus (Stickley and Razvodovsky, 2009). Rural areas here have higher rates of engaging in illicit homemade alcohol, which has worse health effects than the normal beer and wine consumed in urban areas. Most alcohol consumption surveys report that there are higher rates of consumption in urban areas in New Zealand (New Zealand Health Survey, 2006/07), Australia (AIHW, 2005), Canada (Health Canada, 2005), Great Britain (Plant and Plant, 2006), Nordic Countries with the exception of Denmark (Mäkelä et al., 2001) and therefore expectations are that urban areas will have higher rates of alcohol-related hospitalisation. This proved to be the case in Sweden where, after controlling for individual characteristics, alcohol-related hospitalisations were more prevalent in urban areas than rural areas (Kristina and Gölin, 2004). Similarly, in the USA most pancreatitis discharges after admission were higher in the urban areas. There are differences between urban and rural areas but these relationships are not consistent across different national contexts.

2.4.3.2 Alcohol-related mortality

Hazardous consumption is suggested to be one of the main causes of alcohol-related premature death and avoidable disease. The burden of alcohol-related mortality is high, considering that these deaths are avoidable. Globally, hazardous consumption is suggested to cause approximately 1.8 million deaths (3.2% of total) annually (WHO, 2002). Of these, about one-third is accounted for by unintentional injuries alone. Since men are more likely than the women to consume alcohol hazardously, males make up the greater proportion of such deaths (5.6 per cent) than females (0.6 per cent of deaths). However, a recent trend of increases in female consumption means that more women are likely to die from alcohol-related causes. While mortality figures are often given are at a broader international or national level, further examination shows that there are within-country geographic variations stratified by levels of poverty. Alcohol-related mortality is also influenced by age and gender.

Alcohol-related mortality is influenced by geography with significant differences evident between the Eastern and Western European countries, and also between the developed and the developing nations. Richer European countries have lower rates of mortality than their relatively poorer counterparts. In the former eastern European communist states of Bulgaria, Romania, and Yugoslavia, where there are high consumption rates of vodka, 9.7% of the total deaths were alcohol-related, in comparison to the rest of the world where only 3.2% of the total deaths were alcohol-related (Rehm et al., 2007). These differences can be related to the economic restructuring of the 1980s and 1990s following the collapse of the Berlin wall and communism (Curtis, 2004). In the Eastern bloc countries, following the dissolution of the Soviet Union, there was a period of political, social, economic and ideological change which resulted in increased poverty as levels of unemployment increased. Dzurova et al., (2010) argue that the post-communist transformation period not only brought political but also marked lifestyle changes with an increasing demand for alcohol, cigarettes, and drugs. The demand for alcohol was met by a supply of cheap, sometimes illegal, alcohol, also referred to as 'surrogate liquor' (Reitan, 2000). This home-brewed liquor has an unknown liquor potency (Tomkins et al., 2007). The WHO (2009) report that deaths in the Eastern bloc countries have risen significantly since then. Alcohol consumption in these countries contributes substantially to age and gender differences in mortality and life expectancy (Rehm et al., 2007).

In the UK in 2004 there were 8000 alcohol-related deaths, which was nearly twice the total recorded in 1991. This nearly 50% increase in fatalities can be set against an overall population increase of approximately 5% in the same period, as the total population grew from around 57 million to 59.8 million (ONS, 2010). Per capita alcohol consumption is high, and a significant number of people consume alcohol hazardously. Alcohol-related deaths also increased from 0.6% to 1.5% of total deaths, with over 60% of these dying being male (Breakwell et al., 2007). In Sweden, a longitudinal study examined conscripts born between 1949 and 1951 for 15 years. The results indicated after controlling for a range of social background variables, that those who consumed alcohol hazardously had two times higher relative risk of mortality than those who consumed moderately (Andreasson et al., 1988). Hazardous consumption in this study was defined as consuming over 250 grams a week.

At local levels, mortality rates are influenced by socio-economic status, particularly poverty. Poorer areas have significantly higher alcohol-related mortality rates than affluent areas. Emslie et al., (2009) in a Scottish study, reported that alcohol-related mortality in men ranged from 4.2 per 100 000 in Balerno a suburb of Edinburgh, to 176 in Ibrox, Glasgow. For women it ranged from 2.9 per 100 000 in Dyce (a suburb of Aberdeen) to 52.9 for Ibrox in Glasgow. Ibrox is a poor area in Glasgow where whisky consumption is commonplace; its rates are consistently higher than elsewhere for both males and females.

Whilst there are differences between rich and poor areas, there are also significant variations related to gender. Male standardised mortality rates are consistently higher than female rates and this has been attributed to hazardous consumption in some European cities and to the drinking of 'surrogate liquor' in Russia. For all European citizens, approximately 12% of all male and 2% of all female premature death and disability is attributed to hazardous and harmful alcohol consumption. Whilst Scottish male rates of alcohol-related mortality are higher than those of females, both male and female rates have doubled between 1990 and 2000. Based on previous trends in Scotland, a lower increase would have been expected for women. This larger than expected increase has been attributed to the rise in women's alcohol consumption since 1990. In Scotland, age standardised mortality rates for both men (16.1 vs. 32.1 per 100 000) and women (8.1 vs. 15.7 per 100 000) doubled within a decade between the 1990s and 2000s (Breakwell et al., 2007).

Other researchers dispute these figures saying that alcohol-related mortality rates are overstated. Fillmore et al., (2006) suggests that some of the diseases associated with alcohol can also be caused by factors other than alcohol consumption. Pridemore and Kim (2006) argue that it would be possible to compare figures if diseases that are directly attributable to alcohol – including liver alcohol poisoning, cirrhosis of the liver and pancreatitis – were considered rather than examining all the causes suggested to be influenced by alcohol but which are not directly attributable to it.

Liver cirrhosis and pancreatitis are two conditions that have been researched that can be attributed to alcohol. Leon et al., (2006) argue that the rates of hospitalisation and mortality, due to these two conditions, are an important indicator of a population's alcohol-related consumption and harm. Liver cirrhosis is influenced by levels of deprivation both at the national and local levels. The highest mortality rates for liver cirrhosis are observed in the Eastern European countries. This though is not surprising because Eastern bloc countries are relatively poor when compared to the western European Countries and USA and they also engage in a heavy consumption of spirits, which is a risk factor for liver cirrhosis (Ramstedt, 2007, Ramstedt, 2004). Countries with heavy alcohol consumption such as France (9.9 deaths per 100 000) and the UK (7.3 per 100 000) had higher rates when compared to New Zealand and Australia at 2.4 per 100,000 and 3.7 per 100 000 respectively (Bosetti et al., 2007). It is believed that the low rate of liver cirrhosis in New Zealand and Australia is because beer and wine are the alcoholic beverages of choice as opposed to whisky or other spirits. In addition, given that consumption in these two countries has increased only recently, there are suggestions that the drinking currently being observed is a new phenomenon (WHO, 2004), and that more studies need to be undertaken to understand the changes in current drinking patterns. Moreover, while England has more hazardous consumers of alcohol, the English rates of liver cirrhosis are slightly lower compared to French figure. One reason for the difference in cirrhosis rates is that the French consume their wine over a long time period hence they have a higher risk for cirrhosis. The English engage in heavy episodic drinking, increasing their risk for pancreatitis rather than cirrhosis of the liver (Tinto et al., 2002).

There are many limitations with some of these studies. First, the studies all used different methodologies ranging from longitudinal, cross-sectional and prospective to case-controls. Each of these methodologies has their limitations; prospective studies have variable lengths of follow-up and it may be difficult to control for confounding effects (Anderson et al., 1997). Case-control studies vary in the use of controls and this may introduce bias. There are instances where alcohol-related mortality and alcohol consumption data are not correlated. For example, one study showed that the highest mortality rates were in Glasgow and in the London borough of Fulham. When the geographical distribution of mortality was compared to geographical patterns of higher alcohol consumption from a survey, there was a mismatch (Breakwell et al., 2007). This possibly shows that the time lag between hazardous consumption and advent of disease should be investigated. In addition, most studies do not take into account migration status, especially people who move for health reasons, elderly who move into retirement homes or length of residence in an area. In longitudinal studies, some subjects are lost during follow up, thereby reducing the sample size and the ability to make comparisons over time. Other limitations include problems with measurement of consumption, such as using patients whose numbers occasionally were too small to make meaningful conclusions. Other commentators suggest that the variation in alcohol-related mortality lies in the contextual factors that facilitate alcohol consumption rather than in individual factors (Anderson et al., 1993). Despite the limitations, Anderson et al., (1993) state that some of the observed associations are not artefactual and for some alcohol-related deaths there is a dose-response relationship between levels of consumption and risk.

2.4.4 Suggested reasons for variations in mortality and alcohol - related hospitalisations

Differences in rates of hospitalisation and mortality relate to both socio-economic status and individual characteristics. Research has shown that people living in the most deprived areas tend to consume alcohol more heavily than those living in less deprived areas. Breakwell et al., (2007) and Emslie et al., (2009) contend that excess consumption in some areas is related to poverty. This difference affects both genders, although figures for males are higher than those females. The alcohol-related mortality rates for females living in the most deprived areas are three times higher than for those living in less deprived areas, for males there is a five-fold difference between most and least deprived (Breakwell et al., 2007). Research has shown that those who are stressed and lack social capital because of poverty are more likely to be hazardous drinkers (Kawachi and Berkman, 2000). However, consumption and subsequent outcomes are rarely consistent when compared at local level. In the North West of England, for instance, male but not all female alcohol-related mortality was associated with deprivation (Breakwell et al., 2007). These results call for more investigation into the differences that are inherent in deprived areas, since not all deprived areas have similar environmental factors. Macintyre et al. (2002) and Curtis (2004), suggest that contextual factors need further investigation, especially material deprivation and other social determinants. It is such contextual factors that either provide some protection or create risks, thus contributing indirectly to the differences in alcohol-related mortality. There is also a need to understand consumption patterns in areas of deprivation and the contextual factors that are present which facilitate alcohol consumption.

Shkolnikov (1998) argues that deprivation is a result of the general economic development of the country and that the least developed countries have higher mortality related to alcohol than the most developed ones. Such economic development can lead to an increase in waged labour and with some people disillusioned about working conditions many of them turn to alcohol. Tomkins et al., (2007) report that highest consumption in the Russian city of Izhevsk, was recorded in working class men whose mortality rates were also the highest. People living in the most deprived areas were high consumers of alcohol, mostly ‘surrogate’ alcohol. Surrogate liquor is a commercial drink but relatively cheaper that other ‘legal’ liquor However, the study did not fully investigate other contextual factors (e.g. access to alcohol outlets, social capital and cohesion) to further understand whether they were confounding factors.

Variations in alcohol-related mortality and hospitalisation in different geographical areas are also linked to individual factors. Individual characteristics can predispose to alcohol-related hospitalisation and mortality; such characteristics include ethnicity, age and gender. Many studies in the USA and worldwide have often identified minority ethnic groups as hazardous consumers and there is a strong statistical association between mortality and ethnicity (Huakau et al., 2005, Gilbert and Cervantes, 1986, Subramanian et al., 2003a, LaVeist and Wallace, 2000). In the USA, for example, Hispanics were more likely to die from liver cirrhosis than Whites and African-Americans. Conversely, for cancer, more Whites and African-Americans died than Hispanics (Costello, 2006). One suggested reason for this is that minority ethnic groups are more likely to be poor, live in areas of social deprivation and have health problems, hence more stress and a greater indulgence in alcohol. Additionally, areas of social deprivation tend to have higher densities of alcohol outlets.

Ethnic minorities are also more prone to alcohol-related disease and injury. Huakau et al., (2005) found that Pacific Island people in New Zealand were more likely to engage in violence and sustain injuries after alcohol consumption. In addition, diseases that were once not prevalent amongst Māori (e.g. cardiovascular conditions) now are, partly because of excess alcohol consumption (Bramley et al., 2003a). Diverse consumption patterns amongst different ethnic and/or age groups are more likely to result in disparate effects. For example, Connor et al. (2005) report that while alcohol has a protective effect on Europeans because of moderate consumption, for Māori there are more deaths caused than prevented. Overall, Māori had 4.2 times more alcohol-related deaths than non-Māori (Connor et al., 2005) indicating that Māori had other confounding risk factors or that they were heavy episodic consumers of alcohol. Ethnicity itself is not a risk factor but there are both individual and contextual factors that encourage or inhibit consumption amongst the ethnic groups.

Connor et al., (2005) suggested that the difference between alcohol consumption being either a protective factor or a risk factor for older and younger people in New Zealand is that the latter are more prone to injury-related deaths, thus negating the protective benefits. For example, alcohol-related mortality was estimated to have caused 23% of deaths between the ages of 0 to 34 years, with 3% of the deaths occurring between ages 0–14 and 20 % of the deaths occurring in ages 15–34 (Scragg, 1995). There is a linear relationship between alcohol consumption and all-cause mortality, both worldwide and in New Zealand, for young people who are more likely to die from injuries sustained in accidents.

There has been an increase in both hospitalisation and mortality over time in different areas. This is related mostly to increase in hazardous alcohol consumption. However, alcohol not only causes health problems, but is now associated with a range of social problems including crime. The next section examines the relationship between alcohol and crime.

2.5 Alcohol and crime: Introduction

Alcohol and crime have been associated for a long time. Globally, since the 1980s there has been a proliferation of studies that have examined the relationship between alcohol outlets and crime. According to Roman et al., (2008) this interest came from National Institute of Justice reports in the USA showing that up to 40% of those jailed for offences admitted to having consumed alcohol immediately prior to committing the offence (Greenfeld, 1988). There is some certainty that crime is being committed in areas where substance abuse, including alcohol consumption, is taking place and is influenced by distribution of the substance being abused (Alaniz et al., 1998, Parker and Rebhum, 1995). Consequently, researchers started using alcohol outlets as proxies for consumption and found that there is an association between alcohol outlets and homicides, assaults, prostitution and fatal traffic accidents (LaScala et al., 2001, Lipton and Gruenewald, 2002, Speer et al., 1998). Nonetheless, whilst this relationship might be true in other countries, in New Zealand there is general lack of research examining the relationship between alcohol outlets and crime. Gmel et al., (2003a) suggest that most studies have not fully explained the behaviours that surround alcohol consumption and subsequent behaviour, including crime. They suggest that although such behaviours are very complex, research must try and understand the social consequences and different cultures of consumption in country specific contexts. Furthermore, any understanding of the relationship between alcohol and crime needs to be underpinned by a good theoretical basis, one such is opportunity theory (Roman et al., 2008).

2.5.1 Opportunity Theory

Lipton et al. (2003 p 67) was one of the first researchers to state that " public health studies on alcohol outlets tend to be more descriptive in nature, and for the most part have not offered any explicit theoretical explanations as to why high alcohol outlet density and violence are associated with one another". As a result, researchers have suggested that opportunity theory can assist in explaining the relationship between place and crime. This theory is divided into three main components; physical environment, social disorganisation and 'lifestyle' theory (Roman et al., 2008). First, physical environment theory describes the condition of the local buildings and how this may be associated with alcohol consumption and crime (Brantingham and Brantingham, 1981, Roman et al., 2008). Studies using this theory have examined a broad range of crime-related matters , including examining what Roman et al., (2008) describes as the 'location of targets and movement of offenders and victims in space'. Since it is the features of the internal built environment that are more likely to be associated with alcohol consumption, it seems that the exposure to adverse internal conditions may be the key to the relationship between the built environment and alcohol consumption (Bernstein et al., 2007). The definition of physical environment was very narrow concentrating on the built environment and its state. Secondly, social disorganisation theory has been widely used in attempting to explain the relationship between crime and alcohol consumption by examining the links between neighbourhood structure, social control and crime (Roman et al., 2008). This theory suggests that a fragmented society is fraught with many problems such as people drinking on the streets and in cars, the streets being littered with broken bottles, and higher rates of drug and alcohol abuse (Lambert et al., 2004). These are all signs of a disorderly neighbourhood where rules are not enforced. However, the theory does not take into account the presence of institutions that could facilitate consumption and crime (Roman et al., 2008). Most importantly studies need to be able to control for both contextual variables and individual variables to show that social disorganisation is the most important explanation. Lastly, 'lifestyle' theory, also known as victims' routine theory, focuses on social groups and how they inter-relate with other groups and individuals in different places (Cohen and Felson, 1979). Lifestyle activities are routine activities including regular employment, housework, school, leisure activities or whatever other activities are done on a routine basis (Hindelang et al., 1978). 'Lifestyle 'theory tries to capture the exposure of different groups or individuals to dangerous places. Roman et al., (2008) argue that it is important to understand the activities and characteristics of an area that bring together offenders and their victims. This theory has a strong focus on the institutions that are generally known to generate or attract crime, such as alcohol outlets. Roman et al., (2008) argue that the routine activities theory provides a solid foundation for the hypothesis that alcohol retail outlets, such as bars, liquor stores, groceries and supermarkets, attract crime by attracting people of different socio-demographic backgrounds, drawing both the aggressors and victims to one area as part of the normal routine.

2.5.2 Alcohol outlets and crime

Many crime researchers argue that areas around bars and outlets are hotspots for crime (Block and Block, 1995, Roncek and Bell, 1981, Roncek and Maier, 1991, Sherman et al., 1989). Other researchers have also argued that there are other location effects that would promote or inhibit crime, such as physical features of the landscape, deprivation or poverty and the social organization of an area (Alaniz et al., 1998, Gorman et al., 1998a, Gorman et al., 1998b, Scribner et al., 1999). While there is no consensus on which of the contextual factors is important there was recognition that contextual factors are important in crime research. Therefore, researchers have begun to examine the relationship between the density of alcohol outlets and crime. According to Roman et al., (2008), alcohol outlets are important as a proxy for consumption because data on consumption and sales at certain locations are very hard to obtain. Speer et al., (1998), Lipton and Gruenewald (2002) and Lipsey et al., (1997) all calculated the density of alcohol outlets and used regression analysis to show the relationship between alcohol outlets and homicides, assaults and prostitution.

Early studies that examined alcohol outlets and crime concentrated on relationships at a broader geographic level (e.g. cities, zip codes) and combined both individual and contextual variables. An important finding was that an increase in the number of outlets resulted in a significant increase in crime. For example, Scribner et al., (1995) found that in Los Angeles County an increase of one alcohol outlet resulted in 3.4 additional assaults. Individual socio-demographic characteristics explained 70% of the variance in assaults and this increased to 77% when alcohol availability variables were taken into account. Roncek and Maier (1991) found that the addition of an extra bar or tavern in Cleveland resulted in violent crime increasing by 17.6%. Cities with a significant proportion of minority ethnic groups report more crime. For instance, Mexican Americans were shown to have significantly higher rates of crime than White Americans in a nationwide study (Alaniz et al., 1998). It is worth noting that places with higher percentages of minority ethnic groups also had a higher density of outlets. Gyimah-Brempong (2001) in a Detroit study, separated crime into a number of categories (e.g. total crime, property crime, violent crime and homicide) and these were are all positively and significantly related to alcohol availability. Most of the studies mentioned above were cross-sectional and at a broad geographic level, therefore it was very difficult to distinguish which came first, alcohol outlets or crime.

Some researchers have examined changes over time in alcohol outlet density and how these impact on crime. Such authors further separated the different outlets into off-licence and on-licence premises and were interested in examining whether these different outlets had a relationship with different types of crime. Gruenewald and Remer (2006) reported that assault rates were related to both changes in the population as well as a range of place effects including the number of bars and off-licence premises. Areas with a relatively lower income and greater percentage of minorities (Mexicans, African Americans and Indians) had higher crime rates, possibly because of higher rates of alcohol outlets in poorer areas or because of different ethnic groups with different drinking cultures. In such areas, for every 10% increase in the number of outlets, violence went up by 2.1%. Significant changes in population were associated with more rates of crime and hospitalisation days. For example, for every six outlets there was one additional assault that resulted in hospitalisation for at least a day and this percentage increased with increase proportions of males in the population and doubled with a three percent increase in the number of males (Gruenewald and Remer, 2006), indicating that socio-demographics cannot be ignored in crime research. This research was important in illustrating that for some crimes, while outlets are important, changes in the proportions of the male population may explain a large variation. Whilst most studies have concentrated on examining changes within a short time Norstrom (2000) used time series data in Norway from 1960 to 1995 and indicated that for every 12% increase in outlets there was a 6% increase in reported violence. Similarly when examining homicides in a longitudinal study in 256 American cities, Parker and Rebhum (1995) found that the increase in homicide rates was related to a higher density of alcohol outlets. These longitudinal studies are important in confirming that crime has a relationship with alcohol even when investigated over a longer period of time.

Critics of these studies that have been conducted at a broader geographical level, such as cities, suggest that such geographical units are too large and lead to inconsistent results. Scribner et al., (1995) found that alcohol outlets could help in explaining variability in crime. When Gorman et al., (1998b) tried to replicate the study in 223 large municipalities in New Jersey, however, they found that alcohol density was not related to violent crime. Similarly, Gorman et al., (1998a) found that there was no geographic association between alcohol availability and domestic violence. Other researchers have suggested that domestic violence is more related to the number of off-licence premises rather than on-licence outlets and therefore studies should separate the two types of establishments when examining domestic violence. Roman et al., (2008) contend that the differences observed are because of the different outcome variables used and different units of analysis, and that there is a need to examine the geographical variations in much smaller geographic units.

One criticism of early crime research was the large size of the geographical areas such as state, zip codes, cities or regions, studied. Also, few researchers separated the different types of outlets to determine whether the differences in crime rates could be associated with a particular type of outlet. With current advances in GIS, analysis could be undertaken for the different outlets on a much smaller geographical scale. There is a relationship between the density of alcohol outlets and violent crime at census tracts. Gorman et al., (2001), analysed data from census tracts and were able to show that there was a clear association between alcohol density and violence. However, this association was only for the immediate and not the adjacent area. Therefore, to account for adjacent areas, since people do not tend to drink within administrative boundaries, Scribner et al., (1999) created one mile buffers around census tracts and on-licenses rates per person proved to be significantly related to homicide rates although a higher on-site outlet density was not related to higher homicide rates. Whilst the addition of buffers captured information on a wider geographical area, there were suggestions that if buffers are not used, it would be important to control for autocorrelation since the density of outlets in one neighbourhood may affect health outcomes in an adjacent neighbourhood, and result in false positives (Britt et al., 2005). In Minneapolis, Minnesota, the density of alcohol outlets was related to homicide, rape, robbery, aggravated assault, burglary, motor vehicle theft and arson in a census tract, after controlling for neighbourhood effects and auto-correlation (Britt et al., 2005).

Different types of alcohol outlets are associated with different types of crime. Gruenewald and Remer (2006) found that off- and on-licence premises were significantly associated with rates of assault and that alcohol retail outlets such as bars, liquor stores, groceries and supermarkets can attract crime. Whilst both on- and off-licences were associated with assaults, Roman et al., (2008) reported that a high density of on-licence outlets was related to aggravated assault while a high number of off-licence outlets was related to domestic violence. The justification was that cheap alcohol is mostly found in off-licences, where you can buy as much alcohol as you want, consuming it off the premises. Such drinking is not regulated by supervised security supervising/managing drinking unlike in established clubs and this may be one possible reason for domestic violence (Graham et al., 2005, Withrington, 2007). One of the few studies in New Zealand has shown that in Counties-Manukau the higher density of off- and on-licences has a strong and positive relationship with crime (Cameron et al., 2010). Qualitative and quantitative research was conducted in Manukau. Media personnel and community stake holders were interviewed, who reported that alcohol outlets were a source of many social problems, including crime. Quantitative analysis was undertaken to examine the relationship between all alcohol outlets and crime. The results showed that places with higher density of off-licenses had lower alcohol prices and longer opening hours. Additionally, the density of both off- and on-license was associated with social harms and police events. Police events were broken down into categories such as antisocial behaviour, dishonesty offences, drug and alcohol offences, family violence, property abuses, property damage, sexual offences, traffic offences and violent crime. The authors caution that these events were context specific and that care should be taken when applying them to other locations.

2.6 Discussion

2.6.1 Consumption patterns and health outcomes:

Four major themes emerge from this review. First, the Public Health Model captures the 'individual', the 'beverage' and the 'environment' where alcohol consumption takes place. Secondly, after defining consumption patterns and the biological effects, the review established that consumption exhibits distinctive patterns in relation to age, gender, socio-economic status, rural/urban location and ethnicity. Thirdly, rates of alcohol-related hospitalisation and mortality are influenced by the same variables. Fourthly, diseases that were once associated with older people are now becoming common amongst younger and middle-aged men and, more recently, similar patterns are beginning to emerge amongst women.

The Public Health Model and its main domains offer a useful framework for understanding the links between alcohol consumption and related outcomes. The model suggests that it is a combination of the 'agent', 'host' and 'environment' that eventually leads to the different consumption patterns which were defined as abstention, moderate, and heavy episodic or hazardous. Based on these definitions current world alcohol consumption trends were examined. This examination showed that traditional male patterns of consumption are being extended to include certain younger age groups, including younger women. Rates of alcohol-related hospitalisation and mortality were examined and found to be influenced by certain variables related to age, gender, ethnicity, socio-economic status and rural/urban location. Many chronic alcohol-related diseases such as liver cirrhosis and pancreatitis have undergone marked increases in recent years and although they largely remain diseases of the old, especially men, there have been sharp increases in prevalence among younger age groups and women (Leon and McCambridge, 2006).

It is clear that social scientists and health geographers in particular have made a contribution to analysing a dose-response relationship. Researchers have attempted to understand why there are geographical variations at different scales of analysis. Despite conducting many longitudinal and cross-sectional studies, the variations in different studies for different alcohol-related diseases have remained. For example, in the USA, Aarens (1977) tried to summarise the literature and recognized the difficulty in clearly identifying the role of alcohol in mortality and hospitalisation because of the variations observed in different studies. It was difficult to develop one specific attributable fraction due to alcohol for each disease or condition, possibly because of cultural and environmental influences. However, of more interest is an examination of patterns rather than the volume of consumption and its association with mortality and hospitalisation. Analysing both the patterns of consumption and average drinking, rather than analysing each one of them separately, will lead to a much better prediction of how alcohol contributes to rates of mortality or hospitalisation. What is not in doubt is that consumption can have both beneficial and adverse consequences and studies should strive to understand the contextual factors that contribute to hazardous alcohol consumption.

2.6.2 Crime

Early studies that examined the relationship between alcohol outlets and crime focused on states, regions or zip codes, and the results sometimes could not be extrapolated to census tracts. More recent work is able to show similar relationships at census tracts. More specifically, research on crime uses the density of alcohol outlets as a proxy for hazardous consumption. Gruenewald et al., (2006) and Britt et al., (2005) criticised studies which did not control for spatial autocorrelation. Outlets in adjacent or contiguous neighbourhoods may influence crime; therefore researchers need to consider the use of 'buffers' around neighbourhoods to take into account the effects of the number of outlets within walking or driving distance of any given location. The research has shown the relationship of varying crimes to the different types of outlets by separating them into either on-licence or off-licence premises.

Lastly, New Zealand researchers have seldom examined the relationship between density of alcohol outlets and crime. Most studies have concentrated on examining the relationship of injury and car-related crashes to a high density of outlets. This research is important for New Zealand, where the Alcohol Advisory Council (ALAC) suggests that it costs slightly below 250 million dollars a year in solving crime related to alcohol consumption and notes that 75%–90% of weekend crime is attributed to alcohol. This thesis is therefore timely since the Drug Policy 2007-2012 (National Drug Policy, 2007) also mentions crime and alcohol as a major priority for New Zealand. Speer et al., (1998) suggests that new policies should include regulating alcohol outlets because crime would reduce significantly if these outlets were reduced in number and employment opportunities increased. They also suggest that studies should be conducted in smaller geographical units such as meshblocks to better understand the relationship since it is easier to intervene in smaller rather than larger geographical areas.

Crime has several adverse effects. A significant number of people are hospitalised because of injuries sustained as a result of crime in New Zealand (Law Commission, 2009). Crime can also cause fear resulting in stress in some neighbourhoods. The people most likely to be affected are elderly. Studies have shown that those who are scared of their neighbourhoods are less likely to walk or exercise within their neighbourhoods (Liska et al., 1988) therefore having increased risk for obesity and cardio-vascular disease.

While many studies in the UK and USA have used the density of outlets as a measure, very few studies in New Zealand have used such a measure to examine the relationship between crime and alcohol outlets. The New Zealand Ministry of Justice reports that the evidence linking crime to alcohol in New Zealand is largely anecdotal, yet in Wellington alone, alcohol is responsible for 66% of the arrests while 90% of the offences committed on Friday and Saturday were as a result of alcohol (Wood, 2005). Most importantly, understanding how location effects contribute to crime would result in communal rather than individual strategies.

2.7 Conclusion

This review has highlighted how alcohol affects people, illustrating different consumption patterns as well as the biological and chemical effects of alcohol consumption. This provided a basis for understanding how consumption patterns shape rates of alcohol-related mortality and hospitalisation. It is the younger age groups who engage in hazardous consumption and who are the most likely to be hospitalised. The highest rates of drinking are among males. Similar age and gender patterns are reported for mortality and hospitalisation. Minority ethnic groups are more likely to be heavier consumers of alcohol and also more likely to engage in crime and suffer from alcohol-related disease or death. There is also a relationship between alcohol outlets and crime. An understanding of the root causes of hazardous consumption can lead to better intervention practices and ultimately mitigation of negative alcohol-related health and social outcomes. One suggested way is to develop an understanding of how environmental mechanisms, such as location, are associated with hazardous consumption. This is one aim of this research.

There is overwhelming evidence that there are geographical patterns of alcohol consumption and subsequent alcohol-related mortality, hospitalisation and crime. While these differences can be seen in both large and small geographic areas in most cases, whatever the geographical scale hazardous consumption did not match with hospitalisation and mortality largely because of methodological issues or failure to control for some individual and contextual factors. In addition, the time lag before heavy alcohol consumption results into diseases was not taken into account, nor was migration status, nor the length of residence in an area. Investigating alcohol-related behaviour in certain places (e.g. meshblocks, census tracts) would shed more light on an area, rather than solely examining alcohol consumption and its consequences. Furthermore, analysing the effect at the local or in small geographical units is important because hazardous consumption, and more specifically heavy episodic drinking, vary in different locations.

The evidence for changes in alcohol consumption and mortality amongst the lower socio-economic groups and ethnic minorities is complex and needs careful evaluation and interpretation. What is obvious is that studies have been able to link higher levels of alcohol consumption with disease. Some studies have also shown that there is strong environmental influence that needs to be examined. A common theme is that increased consumption is a risk factor for various diseases. Therefore, understanding the environmental factors that influence consumption, an aim of this thesis, will lead to an understanding of the factors influencing mortality. Policy makers could enhance their policies by understanding the ecological factors that contribute to the development of harmful alcohol consumption.

While spatial differences are important in understanding alcohol-related hospitalisation rates there is little understanding of the factors contributing to these in New Zealand. This review points to alcohol-related behaviour as a catalyst for subsequent outcomes. For social outcomes, it is the presence of a number of particular outlets which make the surrounding areas target zones, for crime. In particular, more crime is reported in places with more males and minority ethnic groups living around alcohol outlets. Understanding how the environment affects alcohol consumption is therefore of paramount importance, since most policies targeting the individuals have failed to reduce excess consumption and the subsequent negative outcomes. Environmental intervention may have effective results as it targets the cause rather than the individual. This research will investigate environmental influences on alcohol consumption and set out to address one concern of the WHO Healthy Cities Programme, viz., addressing health inequalities between neighbourhoods (Blackman, 2006, Davies and Kelly, 1993). Public health strategies need to be based on empirical evidence if they are to be effective.

In New Zealand, the 2007-2012 Drug Policy mentions alcohol and crime as a priority; but there is a dearth of studies that examine this link, especially in small geographic units. This is problematic, because ALAC reports that every year $NZ250 million is spent on crime and this money could be channelled elsewhere if alcohol-related crime is reduced. This thesis aims to examine the relationship between alcohol outlets and crime in New Zealand at the level of the territorial local authorities, which are relatively large geographic areas. Understanding this relationship could provide a basis for developing interventions or more research, that are relevant and for a reduction in crime in the longer term. The next chapter will examine the individual and environmental domains of the Public Health Model. These are important in explaining the reasons for hazardous consumption and the subsequent effects.

Chapter 3 Individual and contextual determinants

3.1 Introduction

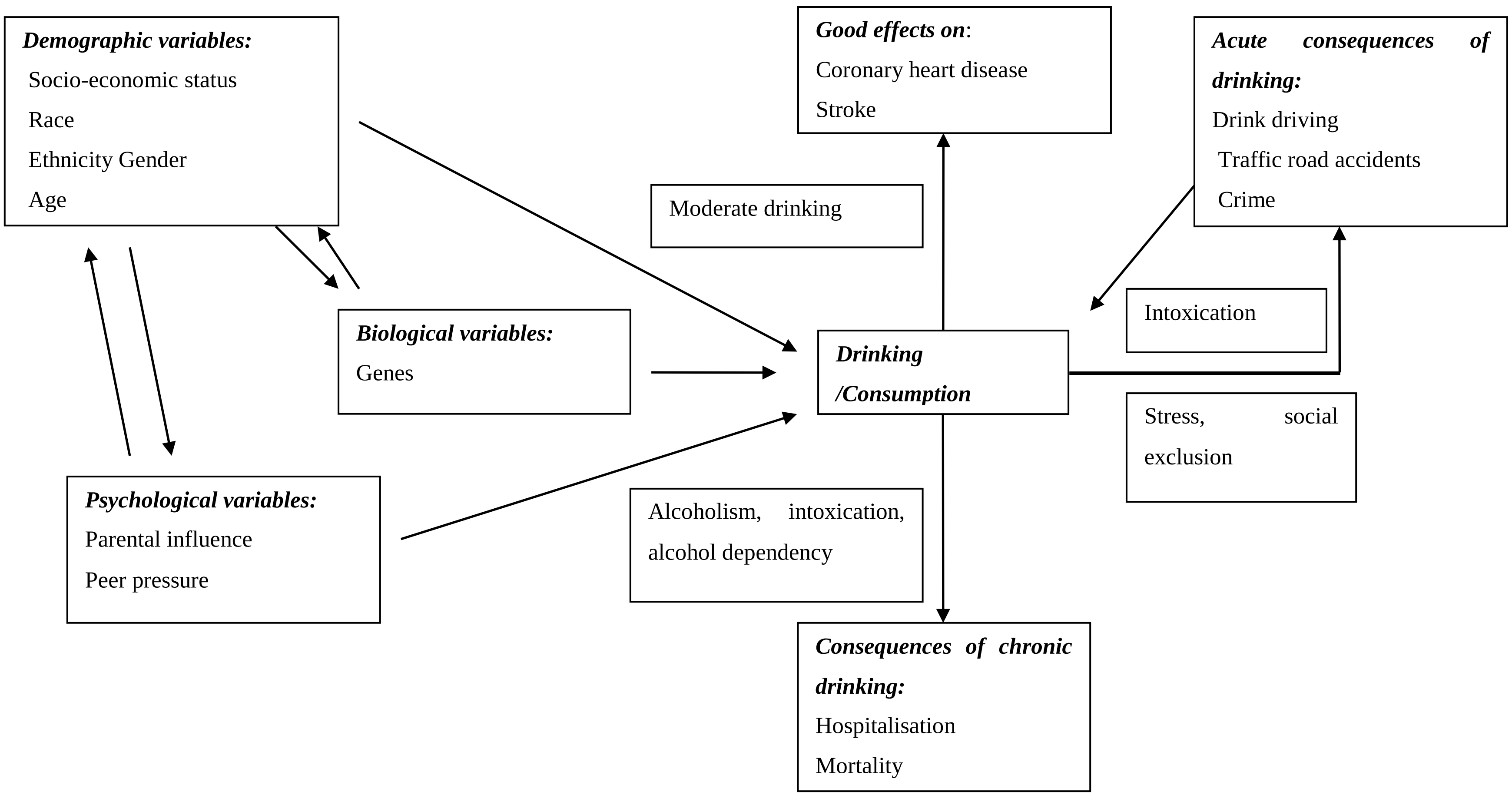
The previous chapter examined one domain of the public health model, alcohol consumption patterns, as well as associated health and social impacts. This chapter examines the remaining domains, namely the individual and environmental characteristics that contribute to hazardous alcohol consumption and the subsequent health and social outcomes.

Variations in alcohol consumption can be explained by compositional factors, and this has been the traditional focus of alcohol research. The observed variations in drinking occur because people who consume hazardously tend to live in certain types of neighbourhoods. These people have similar personal and household characteristics that encourage consumption; in effect, people of the same behaviour congregate together (Smith and Hanham, 1982). According to the Public Health Model, these individual domains, as shown in Figure 3.1, include demographic (SES, race, ethnicity, gender and age), biological (e.g. genes), and psychological variables (e.g. parental influence, peer pressure). These factors combine to determine an individual's drinking pattern (Clapp et al., 2001). However, some psychological domains such as peer pressure are considered to be environmental factors.

Consumption rates are also affected by features of social, economic or physical environment, otherwise known as contextual factors (Macintyre et al., 1993). These factors may influence everyone living in the same area equally, or alternatively may influence certain groups more significantly. The contextual factors as suggested in the Public Health Model include culture, deprivation, alcohol retail outlets, stress, advertising and social capital.

It is against this backdrop that this chapter discusses in detail the individual characteristics (host) and contextual characteristics that influence consumption. The chapter first discusses individual characteristics and how they affect consumption. The second part of the chapter then discusses contextual effects in detail.

Figure 3.1: Hypothetical pathways for individual determinants in alcohol-related behaviour and outcomes



An individual's alcohol consumption is shaped by demographic, biological and psychological factors. These individual factors determine whether one is a hazardous consumer or moderate consumer.

3.2 Individual characteristics

Research on alcohol consumption has traditionally focussed on the individual, and identified individual behavioural choices as important risk factors affecting alcohol use (Bierut et al., 1998). Rice et al., (1998) suggest that most studies are driven by individualistic theory which states that behaviour or lifestyle is an individual's choice and more of an independent habit irrespective of the environment. Figure 3.1 illustrates these individual characteristics including demographic, biological, and psychological variables. Figure 3.1 shows that there is an interaction between these characteristics in determining alcohol consumption patterns. For example, pressure from peers may influence someone who is poor and already at risk of heavy consumption. However, this relation can be modified based on support from parents, because young people who have positive support from parents consume moderately while those without such support are more likely to be 'hazardous' consumers (Droomers et al., 2003). The amount of alcohol consumed is influenced by particular compositional factors. In the following section, each of these is discussed separately, including how they influence consumption and suggested explanations.

Relevant literature was identified using search engines including Scopus, PubMed, Web of Science and Proquest. The search keywords were 'individual factors', 'alcohol', 'consumption', 'heavy episodic drinking', 'age', 'sex', 'gender', 'socio-economic status', 'deprivation', 'ethnicity' and 'poverty'.

3.2.1 Socio-Economic Status (SES)

The observed relationship between SES and alcohol consumption varies, with research showing both negative and positive correlations between SES and increased consumption. Different studies have attempted to measure the relationship between SES (using income, education, and social class) and alcohol consumption (Blomgren et al., 2004, Casswell et al., 2003, Droomers et al., 2003, Luginaah and Dakubo., 2003, Rice et al 1998). What is consistent is that when consumption is measured generally then there is a clear social gradient, with those of a higher social status drinking more than those of a lower social status. For example, those employed drink more that those who are not employed (Blomgren et al., 2004, Rice et al., 1998). However, when hazardous consumers are separated from moderate consumers, less affluent people dominate the hazardous group. Apart from drinking hazardously those in lower SES groups tend to drink more homemade brews which are more potent and are usually drunk in large quantities (Luginaah and Dakubo, 2003).

Using a different measure of SES, those with lower education levels are almost three times more likely to engage in excessive alcohol consumption compared to those with higher education (Droomers et al., 2003, Casswell et al., 2003). Carlson and Vagero (1998) reported that people with lower education and who are manual workers are more likely to be heavy episodic drinkers. This relationship between SES and alcohol consumption is not clear and is further complicated by the criteria used to measure SES. Moreover, there is no consistent pattern between income category and hazardous alcohol use, given that both low income and high income people have been associated with hazardous consumption in different contexts. Significantly, those with higher income, despite having fewer maximum drinks per occasion, were more likely to consume alcohol at least once a week (Casswell et al., 2003, Dawson et al., 1995, Jeffries et al., 2007, Lantz et al., 1998), showing that people of high income were also regular consumers of alcohol.

These differences in SES are surprising because most health studies consistently report worse health status in persons of lower SES. Each of the SES measures used has its limitations and is confounded by the prevailing contextual effects. A study that examined both Jews and Arabs in Israel showed that different results were observed when education, income and occupational class measures were used. Heavy episodic consumption was significant in some groups and not others and differed or changed every time a different measure of SES was used (Neumark et al., 2003). Such results are influenced by confounding factors that are rarely controlled for. Areas with good schools present those living in those areas with good educational opportunities and eventually good employment opportunities. If this presence of quality schools is not controlled for, it may be a confounding factor in the relationship between education and alcohol consumption. More interestingly, among the general population increased SES means an increase in consumption (McKee et al., 2000, Strand and Steiro, 2003), possibly because of greater spending power.

Commentators such as Keyes and Hasin (2008) suggest that SES is complicated and very difficult to capture in research and must therefore be treated cautiously. They cite sociological theories that suggest that income is a good measure of access to and availability of material goods, while educational achievement reflects access to non-material goods. Occupation could reflect power and prestige and therefore each of these might influence alcohol consumption differently. This explanation notwithstanding, contradictory results might occur because of economic restructuring, culture and attitudes towards alcohol consumption and other confounding contextual factors. Other explanations include household composition, stress and isolation.

Economic restructuring worldwide has contributed to variations in alcohol consumption. The economic restructuring of the 1980s and 1990s brought changes including liberalisation of international trade, domestic deregulation of economic processes and privatisation of key services. This restructuring further increased inequalities between and within countries and is suggested to have contributed to an increase in alcohol consumption, especially in transitional economies such as Russia and other Eastern European states (Curtis, 2004). Commentators suggest that most of these people seemed to have suffered as a result of increasing levels of poverty in the 1990s and from a period of income loss in a period of sharply growing income differences (Carlson and Vagero, 1998). Restructuring is associated with more women joining the labour force and as a result women's drinking increased when compared to their male counterparts because of stress as well as role changes (Bloomfield et al., 2001).

Other commentators have suggested that low income status has been associated with other issues that increase consumption. For example, both internationally and in New Zealand, the last two censuses have revealed a change in housing structure where many houses now are occupied by one person or single parent families (Momsen, 2002). This change is because of increases in the rates of divorce and separation and a trend towards later marriage compared to earlier censuses. This change in household structure is a risk factor for excess alcohol consumption because single people are sometimes isolated and may lack psychological support (Isohanni et al., 1994). Isolation can lead to stress, especially when one is not surrounded by a strong community (Jennison, 1992, Sadava and Pak, 1993, Volpicelli, 1987), thereby increasing the risk of substance or drug use.

SES has an influence on individual demographic characteristics (e.g. age, gender and ethnicity) and is responsible for differences in consumption. Some of the individual differences are also partly explained by psychological or biological explanations, such as parental or genetic influence. Levels of parental attachment associated with SES can affect consumption habits. Droomers et al., (2003) suggests that adolescents whose parents were from the lowest occupational group had almost twice the odds of developing heavy alcohol consumption patterns because of low parental attachment. Carlson and Vagero (1998) argue that weakened family ties amongst poor families results in heavy consumption by the parents, especially when their position in the household is threatened. They add that "strain on family ties and the frequency of heavy drinking among men may mutually reinforce each other" (pg 284), and may be passed on to adolescents. In addition, minority ethnic groups are often segregated because of their low income status, which is suggested to be a risk factor for health related behaviour (Kawachi and Berkman, 2000).

3.2.2 Ethnicity

Minority ethnic groups have, for a long time, been associated with increased risks of hazardous health behaviours, including drinking, smoking and poor nutrition. There is evidence that consumption patterns vary between different ethnic groups. There are social and cultural factors that either protect against, or encourage, alcohol consumption within minority ethnic communities. Group or social norms may regulate or control how much alcohol one consumes (WHO, 2002). Alcohol norms and attitudes are predictors of alcohol consumption, in which people with more liberal attitudes about drinking having higher prevalence. There is a higher prevalence of alcohol consumption among the White population in America than among Hispanics and African Americans; the latter peoples have a conservative attitude towards alcohol consumption (Caetano and Clark, 1999). Given that there are both protective and risk factors; consumption varies for minority ethnic groups.

In Europe, consumption patterns among high school students stratified by ethnicity are similar to those in the USA. However, younger members of minority ethnic consume less alcohol compared to other youth. Stewart and Power (2003) compared a sample of African American, European American, and Mexican American high school students and found that overall, European American students showed the highest frequency and quantity of drinking followed by Mexican Americans and then by African Americans, indicating that maybe minority ethnic consumption, similar to smoking studies, was higher in people with little or no education. Similarly, in London, amongst 14-16 year olds recruited from three schools in an ethnically diverse area, White English or White Irish are more likely to drink excessively than black African and black Caribbean youth, but a substantial minority of black African and black Caribbean youth also drink excessively (Stillwell et al., 2004). Similar results were reported in a sample of adolescents between the ages of 11 and 14, drawn from eight secondary schools in south-west London (Best et al., 2001), showing that minority ethnic groups alcohol consumption amongst those in school is lower.

Most ethnic research has been undertaken in the USA (Naimi et al., 2003, To, 2007), as for example in the analysis of Behavioural Risk Factor Surveillance System (BRFSS) from 1993-2001. Their work shows that while European Americans accounted for 78% of heavy episodic drinking, Hispanics had the highest episodes per person of heavy episodic drinking, with African Americans having considerably fewer episodes (Naimi et al., 2003). Ethnic consumption amongst the older population in New York City showed that the European population (21%) have the highest dependency rates followed by Hispanics (15%) and African Americans (11%) (To, 2007). While American studies have always shown consistent results, this is less clear in other geographical contexts such as Europe and Asia where racial differences are not as pronounced. Amongst Asians, higher consumption was found in individuals who had a liberal attitude toward alcohol. For example, the Japanese Americans consume more alcohol than Asian Americans from other nations (Dawson, 1998, Makimoto, 1998). Furthermore, some Asian sub-groups are heavy consumers, for example, in China, Yi ethnic groups are more likely to consume alcohol when compared to the Han ethnic group (Li et al., 2006, Tang et al., 2005), maybe because their culture has more liberal attitudes towards alcohol consumption.

Even amongst minority ethnic groups in the USA, different ethnic groups have varying consumption patterns. When African Americans are compared to people from the Caribbean and other blacks in general, the Caribbean blacks consume less alcohol, showing that there is a need to stratify ethnic groups. Mexican Americans born in the USA report drinking more often but consuming less alcohol. They have three times higher rates of alcohol dependence compared to Mexican Americans born in Mexico (27% versus 9% respectively) (Caetano and Raspberry, 2000). Native Americans also have higher abstention rates when compared to White Americans, but they consume more alcohol per drinking occasion. There are ethnic groups with strong norms against drinking where consumption remains low. In the UK, South Asian 15-16 year olds in Leicestershire consumed less alcohol or were abstainers because they have a more conservative attitude to alcohol (Denscombe, 1995).

New Zealand trends are similar to international trends, with ethnic differences apparent in heavy episodic drinking. Māori are twice as likely to consume alcohol hazardously compared to non-Māori (NZHS 2006/07). The Pacific Drugs and Alcohol Consumption Survey (Pacific research and development studies and SHORE/Whariki Massey University, 2004) reported that Pacific people, stratified by gender, were more likely to consume more alcohol in a typical drinking occasion than other groups within the general population, despite the proportion of drinkers being less (Huakau et al., 2005). The reasons for such ethnic differences are not clear, since both Māori and Pacific Island peoples tend live in low income areas and both are predisposed to poor health behaviours.

There are explanations as to why minority groups tend to consume more alcohol. One reason is that minority ethnic groups are affected by acculturative stress. Commentators have attempted to explain migration and culture, arguing that the way the minority groups are acculturated to majority dominant culture has a big influence on their consumption patterns. If the prevailing culture has a liberal attitude towards alcohol they may create pressure on the norms of the inward migrating groups with more conservative attitudes towards alcohol consumption. Ultimately, some of these groups may end up adopting the cultural norms of the dominant culture. A study investigating Hispanic men and acculturation found that those who had adopted the American culture engaged in heavy episodic drinking similar to the White Americans (Caetano and Clark, 1999). Other reasons include socio-economic stress. As most minority ethnic groups are in the lower social classes they can be disempowered as they lack a financial base or suffer increased stress due to racism (Caetano and Clark, 1999). In addition, other studies have suggested that alcohol consumption among New Zealand Māori can be attributed to the historical injustices of colonialism and the takeover of their ancestral land by Europeans (Perminder, 1990), similar to the aborigines in Australia (Gould, 2001) .

Researchers have questioned the idea that acculturation is a reason for increased alcohol consumption by Māori and Pacific Island people (Perminder, 1990). Such studies have been criticised for failing to examine the neighbourhood features that contribute to consumption, such as; access to alcohol outlets in predominantly poor areas inhabited by minority ethnic groups, the effect of urbanisation in eroding the previously strong social capital and cohesion, and the enforcement of norms against alcohol consumption (Te Ara, 2009). Studies in New Zealand have shown that greater alcohol availability and access is apparent in deprived neighbourhoods (Hay et al., 2009, Pearce et al., 2008a). Most of these neighbourhoods are inhabited by Māori or Pacific Island people suggesting a link between the two factors. There is a need for a more sophisticated focus on the social contexts in which the younger age groups and ethnic minorities lives are enacted (Macintyre et al., 2002).

Other commentators suggest that differences in alcohol consumption between different ethnic groups reflect genetic factors. For Asians generally, their low prevalence of drinking is attributed to biological factors because of a gene-mutation of the gene for enzyme aldehyde dehydrogenase which causes them to feel nauseous, dizzy or experience face flushing, thus they unable to consume a lot of alcohol. This gene is said to be also prevalent in persons from Pacific Islands (Galvan and Caetano, 2003).

These studies show that while there are variations related to ethnic differences, it is not one particular ethnic group engaging in excessive alcohol consumption, although most of those engaging in excessive consumption are from minority ethnic groups. There are suggestions that ethnic consumption is pronounced because minority ethnic groups tend to congregate and live in one area and most of these areas are low income areas where many alcohol outlets are located. Phinney (1996) argues that ethnicity by itself cannot explain drinking patterns. Ethnicity is a broad grouping of people of the same race sharing the same cultural origin within that group and the term should only be used to describe their common experience and values. It should not be used as a means of negative branding. Nonetheless even amongst different ethnicities there are gender differences.

3.2.3 Gender

Numerous studies have established that there are gender differences in alcohol consumption. Males generally consume more alcohol than females whatever the definition of consumption (Wilsnack et al., 2000, Wojtyniak et al., 2005). The quantity and frequency of drinking also varies between the genderes with men more likely to consume more alcohol, often many times in one day. In other words they drink more heavily and more frequently than women. An analysis of national surveys shows that alcohol consumption was higher amongst males in New Zealand (New Zealand Health Survey, 2006/07), Australia (AIHW, 2005), Canada (Health Canada, 2005), Great Britain (Plant and Plant, 2006), Nordic Countries with the exception of Denmark (Mäkelä et al., 2001). Similar results were observed in Asian countries such as Hong Kong (Chan et al., 2007) and Singapore (Lim, 2007). For example, a cross-sectional survey in Singapore (1998-2004) reported that men had higher percentages than women for all types of consumption when measured in terms of heavy episodic drinking (15% versus 3.7%), frequent drinking (9.4% versus 4.6%), and regular drinking (4.3% versus 2.0%) (Lim, 2007). This result is consistent with other international literature.

This gender variation in consumption is further modified by SES, more specifically some occupations predispose people to risk taking. Variation by gender variation is exacerbated by certain occupations for both males and females. In Japan, men of lower income levels have a significantly higher likelihood of excessive alcohol consumption (Fukuda et al., 2005) because of reduced earnings in waged labour making people disillusioned with their occupation. Similarly, in the city of Utrecht in the Netherlands, unmarried people of low education or of low income level were more at risk of hazardous consumption (Verburg et al., 2005), most likely because of stress, isolation, or lack of social control. In Spain, the people with the highest consumption rates were those in low income occupations, mostly farmers and manual workers (Mateos et al., 2002) and men who were non-managers (Moore et al., 1999).

Whilst low income men were more likely to consume alcohol hazardously, historical studies such as the Whitehall Study II, reported that people of higher occupational grade consumed more alcohol than those in the lower grade (Quoted from Macintyre, 1997). However, there was very little difference by grade in the proportion of people in the heaviest drinking category. Amongst women, those who were more affluent had the highest prevalence of heavy drinking. Emslie et al., (2002) assessed the smoking and drinking habits of men and women in non-manual jobs in a university and a bank in Britain and showed that women in senior academic or managerial position were more likely to be heavy drinkers than those in clerical jobs. Similar results were reported in Germany (Burger and Mensink, 2004). This relationship remained even when SES was measured using educational attainment. Whereas men consumed more alcohol, there was a significant increase in consumption for both men and women with increased levels of education and income (Strand and Steiro, 2003). However, when three of the Baltic states of Lithuania, Estonia and Latvia were compared it was Lithuania alone that the odds of hazardous consumption was higher in highly educated men (McKee et al., 2000). This indicates that the relationship between high alcohol consumption and lower SES is only significant in some contexts.

Similar to adults, adolescent males consume more alcohol than their female counterparts. However, this relationship is best illustrated by looking at the larger 15–24 age group. A South African study looked at this wider age group in different South African cities and found that males in this age range were consuming more alcohol than females: Durban, (53.3% males and 28.9% females) Port Elizabeth (58% and males and 43% females) and Cape Town (36.5% males 18.7% female) (Parry et al., 2002). In contrast, in OECD countries such as Ireland and England, countries with relatively high per capita consumption, there were no gender differences in consumption even for the larger 15–24 years age group. In Ireland, 32 per cent of both males and females are heavy episodic consumers compared to England where 26 per cent of males and 24 per cent of females aged 16–24 consumed alcohol hazardously (ONS, 2006). When this age group was further stratified to smaller groups the difference was less pronounced and was minimal in most cases. For example, Mateos et al., (2002) found that in Galicia Spain, there is a clear distinction that older males drank almost twice as much as women. However in the younger 16–20 age groups, an equal number of males and females were high risk consumers. In Argentina, similar results were reported for young people 12–15 years; lifetime prevalence for alcohol use was almost the same, about 40 per cent for females and 38 per cent for males (Secretaría de Programación para la Prevención de la Drogadicción y Lucha contra el Narcotráfico, 2004). There is therefore a general consensus that convergence is more prevalent in the younger age groups for narrower age ranges, but this is this is less evident when broad age ranges are examined.

These similar gender-based drinking patterns are suggested to be as a result of an increase in female consumption rates during the 1990s which are continuing to rise (WHO, 2007). The current female trend is associated with an interest in heavy episodic drinking previously associated with males. In Europe, heavy episodic drinking amongst females increased between 1995 and 2007 (Hibbell et al., 2009). However, a study conducted in the USA disputed the fact that women are drinking more by stating that trends in drinking did not change between 1981 and 2001 (Wilsnack et al., 2006). A similar trend was maintained where few older women drink heavily but younger women engage in heavy episodic drinking.

Several biological and psychological reasons have been suggested for such variations in male and female consumption, including genetic, 'masculinity', cultural, marital and SES factors. It suggested that genes are important in explaining gender differences in alcohol consumption. One explanation why women cannot tolerate alcohol as well as their male counterparts may be due to their bodies having a lower water content (NIAAA, 1996). This focus on genetics has been criticised for not taking culture and environment into consideration, and there are several cultural explanations.

Men's 'masculinity' encourages risk taking in both drinking and smoking (Deemers et al., 2002, Mahalik et al., 2007, Rice et al., 1998, van Gundy et al., 2005, Williams, 2007). Women with higher education and who are willing to take greater risks are more likely to consume alcohol in excess (Celentano and McQueen, 1984). Other studies have shown that the traditionally observed consumption patterns reflect socio-cultural norms where male alcoholic consumption is more accepted than female. Women traditionally were expected to remain sober because of gender roles and to be able to enforce social control including normative and physical control of their male relatives (Wojtyniak et al., 2005).

Some other studies have indicated that this traditional gender role is changing. An in-depth focus group discussion among women drinkers in Uganda reported that women drank to defy gender norms (Wolff et al., 2006). Other explanations have attributed gender differences to drinking cultures adopted while in school or university (Borsari and Carey, 2003, Wechsler et al., 2002) as well as fashion trends that show that drinking is beneficial to health. Some commentators have suggested that research showing that women's drinking is beneficial to health when alcohol is consumed moderately has resulted in many women taking up alcohol consumption (Koppes et al., 2005). For men, there are cultures that pride themselves on hard liquor drinking. Distilled alcohol accounts for one third of all drinks consumed by Chinese men in China and drinking is believed to be an integral part of Chinese culture (Wei et al., 1999). Cultural issues aside, males and females who consume alcohol excessively are often either unmarried or separated (Duncan et al., 1993, Sutton and Godfrey, 1995).

Marital status can influence hazardous alcohol consumption with researchers arguing that being single is a risk factor for consumption. As stated earlier, both single men and women who are isolated and may lack the social support to be able to control their drinking, and they may have no formal or informal networks to inform them of health risks. Similar results were reported in Singapore where those who were younger, male, separated, divorced or widowed were positively associated with heavy episodic drinking (Lim et al., 2007). However, there are other influences such as SES which also contribute to gender differences in alcohol consumption.

SES measured in a number of ways has an effect on gender differences in alcohol consumption. Studies have shown that women managers were more likely to be hazardous consumers while for men it was those of lower SES. Consistent with reports from other studies, women in the senior academic or managerial positions were more likely to be heavy drinkers than those in clerical jobs (Emslie et al., 2002, Moore et al., 1999). This change is attributed to labour market changes which put women in the job market and resulted in a change in social roles. Gender is therefore an important determinant of alcohol consumption as is younger age.

3.2.4 Age

There is evidence that the amount of alcohol consumed as well as the pattern of drinking, varies between different age groups. While younger people are more likely to consume hazardously, older age groups have more abstainers and moderate consumers. The difference lies in the consumption pattern where the younger age group consume more alcohol in one sitting (also referred to as heavy episodic drinking), while the older age groups consume more times but moderately.

There are studies that have consistently shown that the younger people consume more alcohol than all the other groups. In Australia, it was reported that 23% of 14–17 age group and 45.3% of 18–24 age group, consumed alcohol hazardously at least once a month, as opposed to only 20 per cent for all ages (Chikritzhs et al., 2003). There is a general consensus that consumption among this younger age group is on the increase. In England despite the rate of consumption amongst the 11–15 age group decreasing from 67% to 52%, the amount of alcohol consumed increased almost two-fold from 6.7 units to 12.4 units (NHS information centre, 2007). Consequently, people were now consuming more alcohol despite a reduction in the number of drinkers. For heavy episodic drinking, similar patterns were reported where young adolescents are more likely to consume greater volumes of alcohol and report more alcohol-related problems when compared to adults. An analysis of national surveys found that younger age groups were more likely to be heavy episodic drinkers in New Zealand (New Zealand Health Survey, 2006/07), Australia (AIHW, 2005), Canada (Health Canada, 2005) and Great Britain (Plant and Plant, 2006). The highest rates in England, were for those aged 16–24 where almost 25 per cent consumed over the allowed weekly limits (NHS information centre, 2007). However, there is evidence that this pattern does not fit in all the countries and that the difference between the age groups is exaggerated, with higher consumption rates for all age groups.

Researchers have attempted to explain these variations in a number of ways. Alcohol consumption is associated with lower SES. In New Zealand, using different methodologies, lower SES is positively associated with harmful alcohol consumption for all age groups. A survey of people in Auckland, reported that although the number of drinkers has dropped, the amount consumed per session has significantly increased. This pattern was more pronounced among low-income people and teenagers (Alcohol and Public Health Research Unit 1998). Similar results were also reported in a longitudinal study which found that younger people of lower SES consumed more alcohol (Casswell et al., 1991). This status remained even when SES was measured by father's occupation in longitudinal studies (Droomers et al., 2003, Melchior et al., 2007).

Other studies also showed that historical SES background is an important determinant because despite an upward mobility later in life, those who were of lower SES, still consumed an increasingly large amount of alcohol (Poulton et al., 2002). There are suggestions that alcohol consumption in earlier years contributes to consumption in later years and that those who drink hazardously will continue doing so indicating that adolescents, who start consuming alcohol early, continue even in their later years. In Norway, consumption that commences during adolescence is fairly stable throughout life. The evidence was gathered from a longitudinal study that examined Norwegians at ages 19–20, 21–24 and 25–28 years, and reported that those who were heavy drinkers in their adolescence tended to modify their drinking later in life but still drank more than other adults (Pape and Hammer, 1996). Cook and Moore (2001), report that adult consumption is positively associated with levels of youthful drinking. Other researchers argue that there is a decrease in general consumption as one grows older. The plateau of consumption starts after 30 years of age (Johnstone et al., 1996), showing that as age increases, the quantity of drinking decreases (York et al., 2003). Other researchers have attempted to explain that institutions, including schools, play a part in whether one is a consumer or not, specifically because different individual consumption cultures are often established in institutions.

Consequently, researchers examined adolescents in institutions such as colleges, universities and other institutions and compared them to others who are not. These studies have consistently shown that students in ‘normal’ institutions generally have a higher prevalence and frequency of heavy drinking when compared to the other adolescents who don’t go to college or university. However when compared to students who are in alternative education, the latter tend to have a higher prevalence of alcohol consumption. In New Zealand, heavy episodic drinking is more prevalent in students studying or joining polytechnics and universities when compared to people of similar ages who are not in university (Kypri et al., 2005a). Other longitudinal studies have shown that the transition to college from high school showed a marked increase in the prevalence and frequency of heavy drinking compared to high school graduates who don’t go to college (Bachman et al., 1997, Bachman et al., 2002, Paschall et al., 2005). New Zealand students in alternative education tend to be heavy episodic drinkers more often than those in mainstream institutions (Denny et al., 2004), since those in alternative education are often students from ‘unconventional’ backgrounds.

The literature has identified groups that are mostly at risk for alcohol consumption. Young adults are the group most at risk, with evidence that drinking that starts early in life continues into later life. Despite differences in certain studies, there is a general concurrence that the younger age groups consume more alcohol. The research however is inconclusive whether adolescent consumption is associated with future consumption. The Public Health Model suggests that there are some psychological and biological factors that explain why young people consume more alcohol, these include parental influence, genetics, culture and peer pressure.

3.2.4.1 Parental influence

There are psychological explanations for differences observed in individual consumption. One of the hypotheses put forward is that younger people's drinking is influenced by their parents. Rossow and Rise (1994) argue that consumption is influenced by both adolescent or parental circumstances, indicating that those whose parents drink alcohol heavily or live in single parent households have greater odds of consuming hazardously. Family structure influences consumption and those whose parents have died or are divorced, or whose parents are heavy drinkers are more likely to consume alcohol hazardously. This loss or absence of a parent is believed to shape adolescent culture, as well as the adoption of any potential bad habits (Isohanni et al., 1994, Rossow and Rise, 1994). For example, in Taiwan, the probability of a child developing problem drinking was four fold higher if the father was a drinker (Yeh, 2006), showing that dysfunctional families have greater odds of developing risky alcohol consumption patterns. In New Zealand, the frequency of drinking for those aged 13–15 was positively associated with the frequency of drinking of the mother and father (Casswell et al., 1991). This parental influence is linked to a disadvantageous family structural. Emotional attachment between parents and the young children is said to inculcate good moral values and raise the psychological costs of engaging in problem behaviour (Droomers et al., 2003).

Parental drinking is a big influence on young people's consumption patterns. It has been suggested that genes inherited from parents who drink regularly are an important determinant in a child's future alcohol consumption. Hazardous consumption has been linked to genes inherited from parents, with children being four times more likely to consume alcohol hazardously if one parent was a consumer, compared to children whose relatives consume little alcohol (Russell, 1990), this indicates that families have certain genes that confer susceptibility to alcoholism (Bierut et al., 1998, Bierut et al., 2004, Bierut et al., 2000).

3.2.4.2 Genetics

Biologists have suggested that there are genes in human beings that contribute to hazardous alcohol consumption through metabolism and influence on brain physiology. They have isolated genes in human beings that contribute to alcohol consumption or offer protection. A recent genetic study found that polymorphisms in genes of the dopaminergic system appear to influence variations in drinking behaviour (Hopfer et al., 2005). In contrast, researchers found that a variant of the alcohol dehydrogenase is associated with protection against alcohol dependence in Māori (Hall et al., 2007). Research on human subjects commenced after successful studies were carried out in mice in the 1950s and 1960s. This initial research indicated that when the same litter of mice were examined, some mice voluntarily drank a lot because of differences in metabolism (Schlesinger 1967). Similarly, animals experiencing vitamin or any other deficiency increased the amount of alcohol consumed, showing that there were certain conditions in the animal's body that predisposed it to heavier consumption. Preuss et al., (2004) argue that these linkage or association studies have shown either controversial or disappointing findings and that better results would be found if polymorphisms were examined throughout the course of life course, rather than just once in a lifetime.

Despite such criticism, there are indications that genes inherited from parents can contribute to future hazardous consumption. Godwin (1979) found that those who consume hazardously were approximately 25% to 50% more likely to have relatives who consumed hazardously. However, such research was criticised for not showing any association or causal effect. More genetic research was undertaken to better understand how genes operate with a focus on examining twins and how they behave in certain situations. Earlier studies on twins showed a much higher concordance in identical (monozygotic) twins (54 per cent) compared to fraternal (dizygotic) twins (24per cent) (Kaij 1960). More recent research on twins has been inconclusive since some commentators say that there is a relationship between genes and adolescent alcohol use and others say there is no relationship (Siewart et al., 2004). Siewert et al.,

(2004) indicated that there are other behavioural characteristics that appear to either be a risk factor for or protective factor against alcohol consumption in twins (e.g. whether the twins were introverts or extroverts).

Other studies on adopted twins have tested two theories, whether twins would inherit their adopted family's or their biological parent's lifestyle choices. Both hypotheses were confirmed, indicating that genetic research is still inconclusive. Two distinct adoption studies carried out in Scandinavia and America showed that children of alcoholic parents adopted into non-alcoholic homes were four times more likely to be an alcoholic while compared to similar children of non-alcoholic parents (Goodwin et al., 1973, Cadoret and Cain, 1980). Other commentators suggested that adopted children showed evidence of the hereditary and postnatal backgrounds of the adoptees which therefore modified their risk for alcohol abuse (Cloninger et al., 1981).

Since the results on genetics are inconclusive life-time prevalence may provide a better basis for understanding since both genetics and environment have a substantial role to play with the interaction of these factors (Rose et al., 2001, Agrawal and Lynskey, 2008). Rose et al., (2001) reported that age at initiation for both intoxication and abstinence could be explained by the interaction between cultural and environmental influences and genes. Hazardous consumption is explained better by both genes and the family environment.

This inconclusive evidence indicates that there are other factors that have not been investigated that work in conjunction with genetics in determining whether one is a consumer or not, such as the environment, a key factor in modifying genes (Peele, 1986). Bjarnason et al., (2003) suggested that while there is no dispute that biological and genetic factors are important, such behavioural patterns develop in a multilevel social context. Borrowing from other health studies, changes over time in health (e.g. obesity in America) cannot be attributed to genetic factors (Kawachi and Berkman 2003), indicating that the environment has a big effect on health-related behaviour even more than genes. Agrawal et al., (2008) argue that alcohol addiction is multi-factorial and excess consumption is a function of both environment and genetics.

3.2.4.3 Culture

Cultural context, including religion, norms and beliefs, can facilitate or inhibit health behaviour (Macintyre et al., 2002). Cultural determinants, on one hand, may be used to socialise either adolescents or even older people into responsible behaviour, including imposing normative sanctions, while on the other hand, culture might instead promote irresponsible behaviour (Bjarnason et al., 2003). Culture, which is an ‘environmental’ effect, has been associated with influencing youth excess alcohol consumption. The WHO (2004) reports that there is a new cultural trend where youth have created and tolerated new norms of excessive consumption and intoxication. Adolescent drinking culture may also be influenced by the drinking culture of the wider society, such as in Finland, where the old Finnish custom of using alcohol solely to become drunk has strongly influenced the adolescents (Lintonen et al., 2000). Also for the younger age groups (15-24), drinking can also be seen as a way of showing boldness and maturity (Lester and Suzanne, 2005) even if when young. Drinking at younger ages is mostly associated with parties and sports drinking (Kypri et al., 2005b). Both are cultures that are well accepted by younger people, who tend to idolise sports stars. Other studies on drinking cultures indicate that drinking habits tend to be influenced by peers. Those living in a low alcohol environment may be light drinkers while those in a heavy drinking environment, where alcohol is affordable and drinking is socially sanctioned and encouraged will tend to consume more (Edwards et al., 1994, Skog, 1985, Skog, 1980)

3.2.4.4 Peer pressure

Peer pressure is an important contributor to hazardous alcohol consumption amongst the younger age groups. Peer pressure creates situations where youth want to abide by the currents norms of youth culture to be acceptable as a peer, such norms today include a culture of heavy episodic drinking (Sutherland and Shepherd, 2001). Amongst university students, pressure is exerted in groups such as sororities in American universities where drunkenness is tolerated and accepted (Deemers et al., 2002). Heavy episodic drinking amongst peers has been associated with individual traits such as social friendship and tension reduction (Kuntsche and Kuendig, 2005a). Other reasons for drinking include:

- increasing enjoyment and comfort of social situations (enhancing self confidence)
- Increasing confidence in group scenarios
- forging close friendships
- escaping one's problems (e.g. boredom, lack of employment opportunities or stressful situations including exams.

It is suggested that the Chinese consume alcohol to enhance positive social effects, relieve tension and worry, and relieve cravings and withdrawal symptoms (Wei et al., 1999). All these reasons point to situations of trying to emulate friends and remain in association with them, and one's peers.

There is evidence that peer pressure and friendship can increase alcohol consumption or even initiate consumption. Indeed, many studies have shown for young (15-24) and older people (65+) alike, bonding may lead to an improved social life (Sutherland and Shepherd 2001, Kunstche and Kuendig 2005). More research is needed to better understand friendship that increases consumption, especially with some studies showing that some people had peers who abstained. There is therefore a need for more in-depth research to understand the mechanisms of peer pressure, especially if they are shaped by the environment.

3.3 Discussion

The Public Health Model has been used to explain individual differences in alcohol consumption. This review has shown that there are different individual factors than can influence alcohol consumption but individual studies have often been criticised for not taking into account the environment that people inhabit. Commentators have suggested that individual studies do not fully explain the variation observed and therefore the gap can only be explained by environmental factors. However, despite such criticisms there are some lessons that have been learnt from the review.

The literature has identified groups that are at risk for developing heavy alcohol consumption. The group most at risk for heavy drinking is young adults with longitudinal studies showing that drinking that starts early in life often continues in later age. Adolescents from broken homes, who are socio-economically disadvantaged also fall into the high risk category (Isohanni et al., 1994, Rossow and Rice 1994). Other high risk groups include young people in universities and in other institutions. For older people, those who are single or divorced are most likely to engage in hazardous consumption. In terms of gender, males of all age groups were more likely to drink than females but most surveys showing that there is an increase in women's consumption leading to a convergence in younger age groups with both genders engaging in the similar consumption behaviour.

These variables are interlinked and are difficult to separate. For example, when adolescents drink heavily it could because of heavy consumption being a feature of the family background, peer pressure, adaptation to the current youth culture or SES (e.g. Casswell et al., 1999, Droomers et al., 2003, Isohanni et al., 1994, Rossow and Rice 1994). Since some studies do not separate the variables, it is difficult to tease them apart and identify how they each contribute to hazardous alcohol consumption. It is not possible to know whether these variables act independently or whether there are other unknown factors.

Separating out the different explanations was especially difficult for studies that reported one or two variables at the same time. For example, for young people, the research has shown that their consumption is determined by both cultural and demographic situations. Alternatively, parental influence on their drinking was considered and those who are exposed to alcohol early by their parents were moderate consumers as opposed to those who conformed to peer culture (e.g. Droomers et al., 2003, Melchior et al., 2007, Poulton et al., 2002). These studies were inconclusive since most reported a correlation rather than direct causation between adolescent and parental drinking.

Studies of alcohol consumption use various measures of consumption, not necessarily the WHO definition. In addition, results are inconsistent depending on whether education, income or occupational status is used as the variable under consideration. The use of different contributing variables may produce contradictory results. For example, the inconsistency found in the SES literature may be because heavy alcohol consumption is defined differently in all the studies, and different socio-economic measures were used (e.g. Burger and Mensink, 2004, Emslie et al., 2002, Lim 2007, Mateos et al., 2002). Other potential confounding factors are cultural values and attitudes towards consumption. Research needs to take such factors into consideration when examining the effects of individual SES.

Other studies have mentioned that there is a rural-urban difference in alcohol consumption. Most alcohol-related studies have been undertaken in urban settings where it is assumed that most of the drinking takes place because people are isolated and have no support systems (Smith and Hanham, 1982). In addition, all the individual variables (age, gender, SES and ethnicity) interact in the rural/urban setting.

Some researchers tend to insist that health behaviour is an individual problem (e.g. Bierut et al., 1998, Rice et al., 1998). It is crucial to note that the New Zealand Health Survey conducted every two years has shown the individual differences in alcohol consumption over time. Some of the explanations offered by such surveys are more environmental such as culture and social control, with few if any studies, engaging with the environmental effects on alcohol consumption. It is therefore imperative to examine geographical variations in these individual characteristics. This thesis sets out to develop an understanding of what causes some individuals to consume more alcohol than others; it will do so with a specific focus on contextual factors.

While individual factors are important, they have been criticised for not completely explaining the variations. Commentators have suggested that the traditional focus on individual determinants ignored other factors responsible for excess consumption (Diez-Roux 2001, Macintyre et al., 2002). Critics say that traditional research assumed that consumption was an individual problem and ignored the norms surrounding such drinking. Moreover, this early research focussed more on 'space' rather than 'place', ignoring confounders and effect modifiers (Jayne et al., 2008,Smith and Hanham, 1982). Assumptions were also made that geographical scale of analysis was less important than the individual. But research on the Modifiable Area Unit Problem (MAUP) has shown that observed relationships between variables may change depending on the scale of analysis (Exeter and Boyle, 2007, Flowerdew et al., 2008, Openshaw 1984). This work and these criticisms have lead to consideration of environmental and contextual effects on alcohol consumption, which are considered in the next section. A review is undertaken of the key place effects that are suggested as explanations of the observed variations.

3.4 Environment: Place effects on alcohol consumption: A literature review

3.4.1 Introduction

There is a growing recognition that numerous features of the place in which people live and work exert an independent influence on health behaviour and health outcomes (Tunstall et al., 2004). Many features of 'place', including the physical and social environment, have been considered to influence health behaviour (Macintyre et al., 2002) which includes alcohol consumption. Heavy alcohol consumption is an important determinant of avoidable mortality and hospitalisation and has been linked with widening inequalities between groups of differing SES (Rehm et al., 2003, Rehm et al., 2003b). Commentators have suggested that the difference in alcohol-related mortality and hospitalisation can be explained by different consumption patterns, which, in turn, are influenced by the different environments in which people live in (Blomgren et al., 2004, Makela et al., 2001). In view of such trends, the aim of this section is to review existing empirical evidence about the way in which features of 'place' influence alcohol consumption, to complement the last section which examined individual variations. In order to establish 'place' effects on alcohol consumption, the review begins with background information, followed by a discussion of selection criteria. A literature review of 'place' effects on alcohol consumption is undertaken and each of the identified 'place' feature is discussed independently. The review concludes with identified gaps and recommendations for future research.

Such a review is timely for four reasons. Firstly, while recognising that risk factors at the individual level matter, commentators suggest that individual factors do not completely explain the reasons for consumption, and that the nature of drinking contexts should be considered (Casswell and Zhang, 1997).

Secondly, there is a need to identify contextual factors that facilitate alcohol consumption in order to identify gaps existing in the research (Macintyre et al., 2002, Lynch et al., 1997).

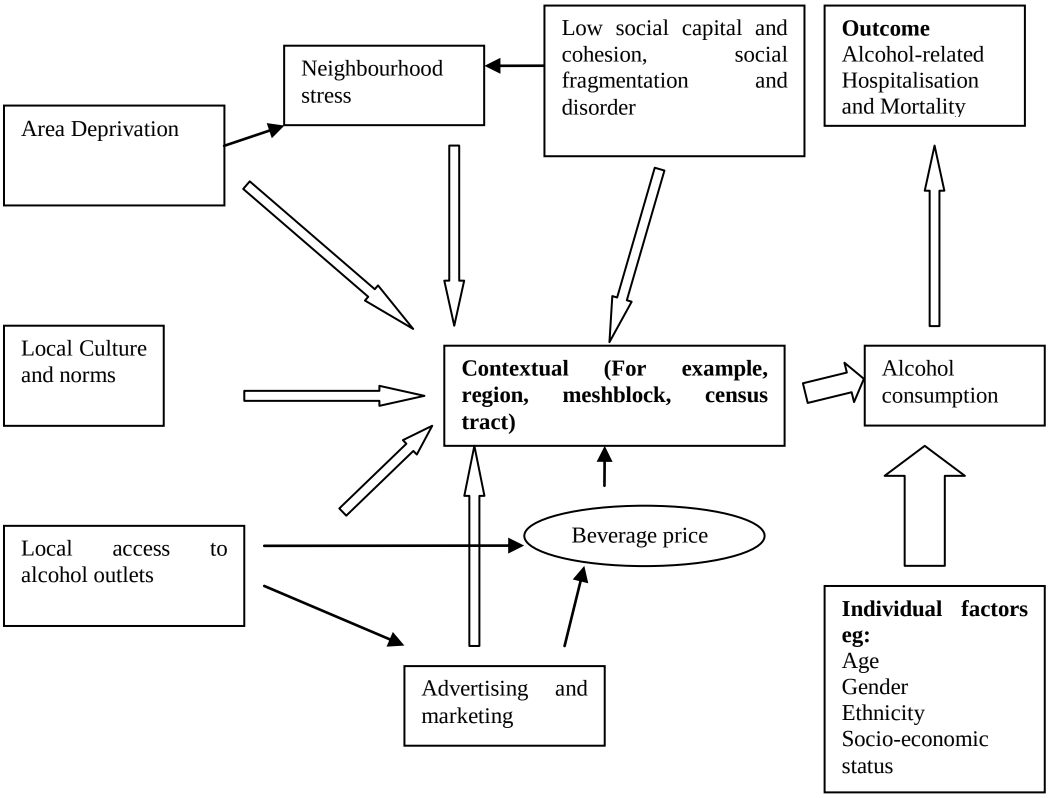
Thirdly, there is no review that has evaluated 'place' effects on alcohol consumption and whether or not they follow the same traditional pattern as other neighbourhood research (e.g. on food and diet).

Lastly, understanding how 'place' influences alcohol consumption has the potential to improve the targeting of environmental intervention, with better outcomes.

3.4.2 Methods

The selection criterion for the literature search was defined as any study that had examined any residential neighbourhood effect on alcohol consumption. Search engines Scopus, PubMed, Web of Science and Proquest were used. The search keywords were neighbourhood, alcohol, consumption, heavy episodic drinking, social environment, socio-economic status, deprivation, social capital and cohesion, social fragmentation, poverty, alcohol availability, alcohol outlets, and alcohol retail outlets. The search produced 1 821 articles with 64 fitting the selection criterion. The potential pathways linking neighbourhood characteristics to individual level alcohol consumption and health outcomes are outlined in Figure 3.2.

Figure 3.2: Explored potential pathways linking contextual factors to individual level alcohol consumption and health outcomes



3.4.3 Results

Some of the main 'place' effects related to alcohol consumption which were identified include: area-level SES; neighbourhood stress; social capital and cohesion; cultural context; retail access; and advertising. McNeil et al., (2006) suggest that those who live in areas with fewer services and resources as well as a constraining social and physical environment, tend to suffer worse health outcomes and behaviours. While the list is not conclusive, most alcohol consumption research identified has examined these broad areas as key environmental factors, despite the lack of a clear definition of the environment. All the identified contextual factors operate within a geographical location, which ranges from regions (e.g. state) to meshblock or census tract. There is an interrelation amongst the contextual factors (Figure 3.2). Researchers using Social cognitive theory as well as social ecological models emphasise the importance of addressing behaviour at multiple levels. For example, individuals without strong social support (social cohesion), may not have stress reduction strategies and could engage in unhealthy behaviour (Berkman et al., 2000). Neighbourhood stress is a therefore a pathway linking deprivation and social capital and alcohol consumption.

Commentators have also suggested that the relationship between neighbourhoods and other pathways in alcohol consumption can be understood by taking into account the broader structural dimension of the global and national political economy. The capitalist mode of economy is suggested to generate uneven development and inequalities in wealth between different geographical regions. The economic restructuring of the 1980s and 1990s brought sweeping changes including liberalisation of international trade, domestic deregulation of economic processes and privatisation of key services. The result was increased inequalities between countries and within countries. These processes, varied between countries as they adopted different regulation policies but they had an effect on people’s economic life (Curtis, 2004). In Russia, following the dissolution of the Soviet Union, there was a period of political, social, economic and ideological change that resulted in increased poverty as levels of unemployment increased. Many turned to alcohol to cope and there was an increase in the demand for and supply of cheap alcohol (Reitan, 2000). Increasingly, national political economies have a direct effect on an area’s SES.

3.4.3.1 Area level Socio-Economic Status (SES)

Traditional research into health inequalities has consistently shown that most of the deprived areas have the worst health outcomes and self-reported health status (Humphreys and Carr-Hill., 1991, Meade and Emch 2101, Robert 1998), For example, in the US, Sorlie et al.,(1995) found that regardless of race, people with lower incomes have higher mortality rates than those with higher income. Gatrell and Elliot (2009) examined data from ONS (1996) and found that life expectancy varied from 75.8 in richer areas to 71.7 years in poor areas in England. They further add that heart diseases and mental illness were much higher in areas that were traditionally industrial compared to areas that were prosperous. It is suggested that the effects of social deprivation on the general population may be compounded by possible health and social problems related to heavy drinking. People of lower SES are more likely to engage in unhealthy behaviours than those of higher SES and their uptake of health promoting behaviour as well as reduction in risky behaviour is less than their affluent counterparts (McNeil et al., 2006). Measures for deprivation have varied in studies and include unemployment, car ownership and income. Sometimes these are combined to form a deprivation index. Many studies have examined deprivation at different geographic levels.

There is evidence that deprivation has an independent affect on alcohol consumption. At a much smaller scale, for example, at meshblock level in New Zealand, there is a social gradient, with the population in deprived areas most at risk for alcohol consumption (New Zealand Health Survey, 2006/07). Differences in deprived areas are further modified by differences in age and gender. Over a six year period (1989-1995), Finnish neighbourhoods with high rates of unemployment had increased risk for male but not female alcohol consumption (Karvonen and Rimpela, 1997). In the UK, the NHS reports that young people aged 16–24 who were living in the most deprived areas had a higher prevalence of hazardous alcohol consumption (NHS information centre, 2007). Moreover, the highest rates are in the North East of England in Yorkshire and Humberside where younger people are most likely to have consumed two times more alcohol than the rest of England (Fuller, 2008). This shows that deprived areas influence or enhance consumption compared to the affluent areas. Of further interest 33 per cent of a sample of young adults living in deprived communities in UK did not know the definition of heavy episodic drinking, yet 39 per cent fell into this category while 15 per cent were hazardous consumers (Talbot and Crabbe, 2008). The risks may be exacerbated by advertisements and alcohol outlets concentrated in deprived neighbourhoods, encouraging young people to consume more alcohol.

In contrast to the New Zealand and English surveys, a study in the Russian Federation reported that material deprivation was not related to alcohol consumption (Bobak et al., 1999). Similar evidence from Scotland, the Netherlands and Taiwan, after controlling for a range of individual/household characteristics, reported no neighbourhood SES effect on excess alcohol consumption (Ecob and Macintyre, 2000, Ellaway and Macintyre, 1996, Chuang et al., 2007, Monden et al., 2006a). These results were surprising since most studies find health and health behaviour to be worse in deprived areas.

Whilst alcohol consumption studies showed inconsistent results, other health behaviours have an independent association with deprivation. In New Zealand, Barnett (2000), after controlling for a range of factors, found that smoking rates were higher in the most deprived areas. Similarly, in Britain, Duncan et al., (1999) using multilevel modelling also found that neighbourhood deprivation had an independent effect on individuals' smoking habits. Other health behaviour studies show an association between area SES and unhealthy diet patterns and obesity (Ellaway et al., 1997), and reduced physical activity levels (Yen and Kaplan, 1999a). These studies have been able to demonstrate that after controlling for a range of confounding variables, area deprivation has a significant relationship with health behaviour.

In some cases research has indicated that for alcohol, consumption is actually higher in the least deprived neighbourhoods in the USA (Galea et al., 2007). Scientific discourse suggests that the difference observed in small areas between 'place' effects and alcohol consumption arises as a result of differing definitions of alcohol consumption and methodologies used. Against this backdrop other researchers suggest that deprivation is a proxy measure for other area affects and it would be prudent to have direct measures of what are the physical and social constraints in these deprived neighbourhoods in relation to alcohol consumption behaviour (See Figure 3.2). However, not many studies have engaged with these contextual factors. The few that have been undertaken have suggested some pathways linking neighbourhoods to alcohol consumption. These pathways are discussed in the following section.

3.4.3.2 Neighbourhood stress

People living in poor neighbourhoods are more vulnerable to stress because they have fewer psychological support resources to help them cope. Heavy drinking is suggested to be a way of coping especially if alcohol is available nearby (Jennison, 1992, Volpicelli, 1987, Sadava and Pak, 1993). In the USA Linsky et al., (1987) examined 50 states and used 15 measures of stress varying from rates of divorce to community disasters, and found that increased stress levels are associated with an increase in alcohol consumption.

There are features of a neighbourhood that can increase stress, such as unemployment. A high rate of unemployment increases stress because neighbourhoods lack necessary social and economic resources. Such neighbourhoods report an increase in violence, crime, and poor housing, producing a perceived lack of social control and which is thought to lead to more alcohol consumption (Pohorecky, 1991). For example, in the

USA, after controlling for psychosocial characteristics and life events, there is evidence that among the urban African American, and Hispanic youth, perceived neighbourhood stress is associated with alcohol consumption (Scheier et al., 1999). Disorganisation and lack of informal social control in neighbourhoods also has an effect on adolescents in the USA (Scheier et al., 1999). Lambert et al., (2004) reported that adolescents are more susceptible to heavy drinking when they are living in unsafe neighbourhoods with higher rates of violence and drug use. Similar results were observed in youth aged 12–17, who were at more risk of alcohol use and dependence because of living in disorganised neighbourhoods (Winstanley et al., 2008) possibly because they saw that norms of disorganisation were accepted and tolerated.

Another suggested cause of stress is incivility, which is common in areas of poor SES. According to Warr et al., (2009) there are two types of incivility; social and physical. Social incivility is defined as behaviours that are in contrast to widely held norms and beliefs, for example public drinking, vandalism, blatant drug use, street fights or criminality. Physical incivility includes abandoned buildings, graffiti, litter on the streets, broken windows, etc (Warr et al., 2009). When such incivilities exist in an area they are likely to increase stress because people who live in such areas may be afraid to walk out of their house for fear of being robbed. Such residents tend to have a bad perception about their areas thus increasing stress which can lead to excess alcohol consumption. For example, in Illinois, USA people living in areas of low SES have worse health than people of affluent neighbourhoods and this was influenced by perceived neighbourhood disorder and fear. Stress associated with disorder was suggested to be one of the reasons for ill health (Ross and Mirowsky, 2001). As such incivility is common in deprived areas it may be a reason for poorer health experienced by those living in them.

As discussed earlier, being poor increases your chances of stress, depression and anxiety and is suggested to trigger a harmful biological process that could lead to mental illness, cardiovascular disease and, in some cases, suicide (Carlson and Vagero, 1993, Linsky et al., 1997). To cope, people may turn to alcohol consumption. Neighbourhood stress is therefore an important pathway linking features of ‘place’ with alcohol consumption and is associated with social deprivation, income inequality, low social capital and cohesion.

3.4.3.3 Social Capital and Cohesion

Social capital and cohesion are core social environmental factors that influence the association of socially deprived areas with hazardous health behaviours (Diez Roux 2001, Macintyre 2003). These influences can be positive or negative, but socially integrated societies tend to experience better health outcomes than poorly integrated ones (Wilkinson, 1996). Lack of social capital may result in higher rates of smoking (Siahpush et al., 2006) and alcohol consumption (Weitzman et al., 2003b). Questions abound as to how social capital and cohesion influence health and commentators have suggested that underlying mechanisms include 'bridging' and 'bonding' social capital. Bonding social capital is a network of members who have similar beliefs and includes diffusing of behavioural norms to friends and members of a family (Putnam, 2000). Bonding social capital is therefore important for establishing and maintaining healthy norms as well as controlling deviant behaviour and protecting the vulnerable.

Researchers have suggested that the bonding construct of social capital and cohesion has an association with individual alcohol consumption through differing levels of social participation, norms and trust. The first suggestion, social participation, can contribute to an increase or decrease in consumption. Low levels of social participation result in individuals who are socially isolated, who tend to over-drink and engage in other health damaging behaviours (Putnam, 2000). Evidence from Taiwan shows that more males were consuming more alcohol because of social isolation (Chuang and Chuang, 2008). Using multi-level modelling, this study found that neighbourhood social participation was associated with male drinking after controlling for individual differences. The authors suggest that the structural dimension of social capital may increase opportunities for alcohol consumption by forming social contexts that enhance drinking norms. Suffice to note that alcohol consumption was defined by frequency of consumption, with those not drinking or drinking occasionally as one group of moderate consumers. The other group consisted of those who drank often but rarely got drunk or those who got drunk as high consumers. As mentioned earlier, consumption measurements often differ between studies. Other researchers have argued that neighbourhood disadvantage inhibits the specific forms of social capital and in turn places constraints on the ability of local residents to check on each other's drinking, leading to a lack of collective efficacy (Kawachi and Berkman, 2000).

Individuals who are socially isolated may not be able to cope with stress and are therefore susceptible to increased alcohol consumption and other substance abuse (Lindstrom, 2000). Alcohol becomes a form of coping mechanism as it confers some relaxation (Lindstrom, 2008).

Alternatively, when social participation is high there are better social networks which help in reinforcing healthy norms, social ties and offer some protection (Bolin et al., 2003). Weitzman and Kawachi (2000) found that area-level social capital, measured by volunteerism, had a protective effect against heavy episodic drinking amongst college students in the USA. Berkman et al., (2000) suggest that having supportive social relationships might enforce good behaviour. Other researchers dispute this theory and suggest that a high level of social participation can actually lead to more consumption and that the effect of social capital can be both negative and positive. A study in Los Angeles, which examined 2620 adults in 65 census tracts, found that a high level of neighbourhood support (as measured using a range of variables) was associated with higher odds of heavy episodic drinking (Carpiano, 2007). Similar results were reported in Sweden, after controlling for a range of socio-demographic characteristics, high levels of social participation and low trust led to excessive alcohol consumption among men (Lindstrom, 2005). This latter study suggested that low levels of trust were a more viable explanation for alcohol consumption. Associations between social participation and increased consumption have also been observed for smoking (Stead et al., 2001)

Whilst the research on trust was inconclusive, there is evidence that lack of trust in both informal and formal institutions is a pathway to increased consumption levels (Ahnquist et al., 2008). It is suggested that informal institutions, such as social groups, contribute to an increase in social capital because of stronger social ties. Such groups may gather and/or relay relevant health information quickly and reduce negative perceptions about neighbourhoods (Yip et al., 2007, Lindstrom, 2005) by, for example, participating in crime reduction. However, when people lack trust in these informal institutions, they may become socially isolated and stressed and more at risk for high alcohol consumption (Yip et al., 2007). Trust in formal institutions, such as the health care system and political institutions, is the other pathway. Evidence from Sweden shows that lack of trust in health care and political institutions is associated with an increased likelihood of illegal purchases and harmful alcohol consumption (Ahnquist et al., 2008).

The second mechanism, 'bridging social capital', relates to individuals who are not similar in terms of their social identity and include civic non-participation or lack of trust in political institutions (Putnam 2000). An example is a civil society which represents the voiceless whose protests can result in a change in public policies. 'Bridging' social capital is therefore seen to provide opportunities for disadvantaged groups to access material resources through connection to socially advantaged groups. Studies have linked civic participation to moderate alcohol consumption in England (Poortinga, 2006) while those not engaging in civic participation were hazardous consumers. As indicated earlier, different studies use different measurement. For this research, alcohol intake was directly reported by the respondents who were then divided into three groups: those not drinking at all; those drinking less than 2 units per day (classified as moderate consumers); those drinking more than 2 units a day (classified as hazardous consumers). Researchers have suggested that lack of political trust, in common with socio-economic deprivation, can be linked to the economic restructuring deployed by many governments in the 1990s. This restructuring resulted in an increase in unemployment and economic upheaval, including the privatisation of services which led to the introduction of hospital charges (Curtis 2004). This uncertainty took a heavy toll on social relations, hence the loss of social capital. Examples are cited of many eastern European countries (Curtis, 2004, Dzurova et al., 2010, Carlson and Vagero 1987) and especially Russia when the Soviet Union collapsed (Rose, 2000).

It is worth noting that communities strong in social capital are more likely to oppose the location of bars in their neighbourhood and have neighbourhood norms restricting excessive consumption. Neighbourhoods with weaker social capital would likely see the reverse effect on alcohol outlets and consumption. Hazardous consumption, in and of itself, can also lead to lower social capital and poorer social cohesion and their consequences. With a loss of social capital and a lack of norms to regulate people's behaviour, perceptions about neighbourhoods may become negative because of the low level of informal social control (Marmot, 1997). Individuals may adopt unhealthy behaviours such as smoking or alcohol consumption when stressed as a result of poverty or deprivation. Having supportive social relationships, on the other hand, brings the probability of reducing such behaviour (Berkman et al., 2000). Lack of strong social capital in deprived areas which have many alcohol outlets can further worsen the situation. These neighbourhood variables are therefore intertwined.

Research has found it difficult to measure social capital especially since it has two distinct components. On one hand, social capital is a function of individuals and their social interactions within social networks; while on the other hand, it is a collective attribute of communities and societies (Kawachi et al., 1999, Stafford et al., 2003, Subramanian et al., 2003b). Researchers suggest that to unpack social capital, empirical studies on health should be analysed using a multi-level modelling technique which can examine both individual and contextual level mechanisms, since both components are complementary (Szreter and Woolcock, 2004). Different studies have used varying measurements such as collective efficacy, volunteerism, reciprocity or even political participation. It is difficult to choose which of these variables is most important. Teasing out how each of the measurements is related to consumption is difficult and although Weitzman et al., (2000) reported that volunteerism resulted in a reduction in the amount of beer consumed, there was no explanation given about why this should be. One suggested explanation was that maybe the time for drinking was reduced or that strong social ties and societal norms controlled behaviour and were related to culture.

3.4.3.4 Culture

One way that ‘place’ influences alcohol consumption is through cultural context. This includes norms and beliefs of the society which can facilitate or inhibit health behaviour (Macintyre et al., 2002). Culture can be understood as a shared way of life for particular social groups in particular places. It encompasses behavioural norms and ways of seeing the world. Beliefs and norms are strongly related to social capital and cohesion, and may be used to either encourage people into responsible behaviour or promote irresponsible behaviour (Bjarnason et al., 2003). Berkman and Kawachi (2000) contend that communities that exhibit strong social capital may enforce social norms for promoting health behaviours. For example, religion is an integral part of culture, and can be used to impose sanctions. Culture is, however, dynamic and changes with time and new cultures emerge (Smith and Hanham, 1982). Culture can therefore be divided into two types; cultures that protect against excessive alcohol consumption and those that increase the risk of heavy alcohol consumption.

Cultures that impact on alcohol consumption either moderate or facilitate the quantity consumed. Room and Makela (2000) cite examples of Mediterranean alcohol cultures, which have been widely characterized by moderate daily consumption of wine, whereas the Nordic countries have been noted for sporadic bouts of heavy spirit consumption. Examples are cited of Swedish alcohol culture where, while fewer people consume alcohol, there has been an increased level of heavy episodic drinking (Popova et al., 2007, Thor, 1998). In the 1980s, Finnish adolescents adopted and maintained a culture of drinking to get drunk (Lintonen et al., 2000). While these cultural differences are at a broad international level, there are subtle cultural differences in much smaller geographical units. Neighbourhood norms about drinking and drunkenness are associated with heavy episodic drinking (Greenfield and Room, 1997, Room and Mäkelä, 2000). There are community contexts that encourage alcohol consumption including gatherings for ethnic food, music, traditional ceremonies and general socialisation including home parties (Yu and Stiffman, 2007, Gilbert and Cervantes, 1986). In New Zealand, alcohol consumption is often associated with watching and participating in sport, particularly but not exclusively amongst younger people (Kypri 2005)

Cultures that protect against immoderate consumption include religion. Religion is an integral part of a culture, and can create norms that impose sanctions against drinking. Religion can also provide individuals with an opportunity to seek and gain social support as a coping mechanism when dealing with painful emotions and feelings (Beeghley et al., 1990). Regions such as the Central and Northern Ostrobothnia in Finland, where religion is an important part of life, people are low alcohol consumers because the Laestadian religious movement does not allow the use of alcohol (Blomgren et al., 2004) as well as providing support for other members as a coping mechanism. Studies in the USA among college students have shown that religious affiliation reduces alcohol consumption; however, there is no consensus on the level that confers protection. Religious commitment was a better predictor of protective factors than a simple measure of religious membership. Baer et al., (1993) found that students who were committed to religion were more likely to drink less, as they were provided with opportunities for other activities rather than alcohol consumption. Additionally religion is typically a communal affair and everyone is watching each other especially their behaviour and offering support to those who may ‘stray’. Many mainstream churches restrain their members from consuming alcohol completely through collective social responsibility Olencko et al., (1991), found that frequent attendance at religious services was associated with reduced drinking. Furthermore, states in the USA which have a higher proportion of Catholics, have higher rates of alcohol consumption compared to states with more Protestants (Holt et al., 2006), since for Catholics, drinking is allowed and not prohibited .

In the USA, migration can be either a protective or a risk factor. There are suggestions that some ethnic groups migrate from areas of high alcohol consumption to areas of low consumption and change their drinking behaviour as a result. Others however migrate to other areas and become acculturated and adopt new, less moderate behaviours. Those living in rural areas are suggested to be moderate consumers, because of social control, which is lacking in urban areas (Smith and Hanham, 1982). Acculturation has a big influence on changing consumption patterns, and minority ethnic groups that adopt a liberal attitude to alcohol tend to consume more alcohol. In New Zealand, Māori and Pacific Island people’s drinking culture can be attributed to their acculturation to the European Irish or Scottish culture of whisky and heavy consumption, historically adopting the culture of incoming migrants.

Migration is not necessarily across international borders, it can also be from urban to rural areas or vice versa. According to Smith and Hanham (1982), urbanism has a positive relationship with increased alcohol consumption. Smith and Hanham (1982) argue that the highest consumption for both men and women is in urban areas with most abstainers from the rural areas. It is suggested that there are strong cultural norms in the rural areas that control hazardous consumption but such controls are generally lacking in urban areas. Culture is therefore intertwined with social cohesion as well as location (urban or rural), and other individual factors.

New emerging cultures, associated with modern lifestyles include new drinks that are mild or sweetened and are mostly targeted at women, mostly promoted by alcohol selling companies. These new trends encourage non-traditional consumers to consume more while at the same time indicating that such drinking is trendy and in keeping with the times. As mentioned earlier, these emerging cultures promote the consumption of alcohol in certain places and with their own set of ‘laws’, customs and values (Social Issues Research Centre, 1998). The environment where consumption occurs, including the retail outlets, is important in terms of understanding such new cultural trends.

3.4.3.5 Retail access

Alcohol intake is influenced by deprivation with people living in poorer areas more susceptible to excessive alcohol consumption. One factor that has received increased attention in the last decade is the access to and availability of alcohol outlets and whether or not a social gradient exists. Evidence from New Zealand and the USA shows that more alcohol outlets are located in deprived neighbourhoods (Pearce et al., 2008a, Pollack et al., 2005) but not in Glasgow (Ellaway et al., 2010). In the USA, African American communities are particularly susceptible, given that they have higher concentrations of outlets than is typical in most low income urban communities (Bluthenthal et al., 2008, LaVeist and Wallace, 2000, Romley et al., 2007). There are suggestions in the US studies that outlets deliberately locate in deprived areas and African American neighbourhoods where there is less opposition because of lack of social capital (Livingston et al., 2007).

Table 3.1 illustrates the studies that have examined relationship of access to alcohol retails and impact on alcohol consumption. Beginning with earlier studies, mostly from the United States, have shown that excessive alcohol consumption is related to alcohol outlet density and an increase in number of outlets per capita is associated with increases in consumption (De lint and Schmidt, 1971, Rush et al., 1986a). In addition, states with high rates of on-license alcohol outlets have higher rates of consumption (Douglass et al., 1980, Harford et al., 1979). These earlier studies looked at a wide geographical area and relied mostly on the presence or absence of alcohol outlets in relation to the total population. They were criticised for not controlling for confounders such as socio-economic factors and for failing to include simultaneous effects into the models. Critics suggested that geographical dispersion, rather than population distribution, was important in determining the relationship between availability and consumption (Gruenewald, 1993a).

Table 3.1: Studies on access to alcohol retails in association with alcohol consumption and variables controlled for.

STUDY	POPULATION-TARGET GROUP AND GEOGRAPHIC LEVEL	VARIABLES CONTROLLED FOR	RESULTS
De Lint et al., (1971) Rush et al., (1986)	General Population at State level	None	Increase in number of outlets per capita was associated with an increase in consumption
Harford et al., (1979)	General Population at State level	None	States with high rates of on-premise alcohol outlets tended to have higher rates of alcohol consumption
Godfrey (1988)	Econometric study in England	None	An econometric study in England investigated the effect of gradual change in alcohol density on consumption using time series data from 1956 to 1980 and found that there was an association between licensing and beer consumption, but none for wine and spirits.
La Veist et al., (2000)	African American Communities at census tract level	Controlling for census tract socio-economic status	More outlets located in African American neighbourhoods.
Scribner et al., (2000)	General population at Census tract level in New Orleans (24 census tracts)	Controlling for individual level socio-demographics and neighbourhood deprivation	Neighbourhood level outlet density was significantly related to drinking norms and consumption, but not individual measures of accessibility.

STUDY	POPULATION-TARGET GROUP AND GEOGRAPHIC LEVEL	VARIABLES CONTROLLED FOR	RESULTS
Weitzman et al., (2003a)	University students in Public universities in different geographic regions in United states and set in different communities for example small town, urban, suburban.	None	Outlet density has been found to be closely related to heavy and frequent drinking and drinking related problems among college students' drinkers as well as in different sub groups, such as females.
Weitzman et al., (2003b)	University students in 140 colleges across the US, mostly first year freshers	None	Most college binge drinkers reported that they were exposed to 'wet' environment when compared to non-binge drinkers. Wet environments included social, residential, and market surroundings in which drinking is prevalent and alcohol cheap and easily accessed.
Pollack et al., (2005)	General population living in four cities in California (82 census tracts)	Controlling for individual level socio-demographics and composite SES measures	No association between distance to alcohol outlets and consumption.
Kunstche et al., (2005)	9^{th} graders in schools in Switzerland aged between 12-18	Controlling for level of urbanization	Areas with higher density, despite having a low perception from school masters had higher drinking rates
Dent et al., (2005)	Students AGED 16-17 in 92 communities in Oregon	None	There is an association of youth drinking and commercial access

STUDY	POPULATION-TARGET GROUP AND GEOGRAPHIC LEVEL	VARIABLES CONTROLLED FOR	RESULTS
Kunstche et al., (2008)	8th and 9th graders in 254 communities in Switzerland	None	Community-level perceived availability and the density of on-premises but not off-premises outlets were related to volume drinking but not to the frequency of risky drinking occasions.
Truong (2007)	General Population at Census tract level in California	Controlling for individual level socio-demographics and neighbourhood deprivation	On-license outlets within a radius of one mile were associated with excessive consumption
Romley et al., (2007)	Alcohol outlets within African Americans neighbourhoods at census tract level	Controlling for census tract socio-economic status	Higher density of alcohol outlets in African American neighbourhoods
Huckle et al., 2008	12-17 year old young drinkers in Auckland at Meshblock level	Controlling for individual level socio-demographics (and deprivation for some analysis).	Alcohol outlets were associated with quantity of consumption and also associated with deprivation in New Zealand
Kypri et al., (2008)	Six university campuses in New Zealand	Controlling for gender, age, ethnicity and high school binge drinking frequency, and adjustment for campus-level clustering.	There was a positive relationship between outlet density and individual drinking as well as for personal problems
Scribner et al., (2008)	17, 500 students in 32 colleges in the United States of America	Controlling for individual predictors of college drinking	On-Licenses located off campus have a strong association with college drinking outcomes.

STUDY	POPULATION-TARGET GROUP AND GEOGRAPHIC LEVEL	VARIABLES CONTROLLED FOR	RESULTS
Pearce et al., (2008)	Alcohol outlets in New Zealand urban areas	None	Most deprived areas have disproportionately better access and higher densities of alcohol outlets, measured both by distance and buffers of 800 and 3000 metres.
Hay et al., 2009	Neighbourhood deprivation and access to alcohol outlets	None	Most deprived areas have better access to alcohol outlets

Recently, cross-sectional studies have examined geographical dispersion, by using Geographic Information System (GIS) and multi-level modelling that combines individual data from population surveys with aggregate community level data. These studies have produced mixed results. For example, evidence from California shows that, after controlling for individual and neighbourhood socio-demographics, on-license outlets within a radius of one mile were associated with excessive consumption (Truong and Sturm, 2007). Thus having outlets closer may increase consumption. Proximity to outlets is also sometimes measured using density, that is, number of outlets per person and Scribner et al., (2000) reported that in 24 New Orleans census tracts, neighbourhood level outlet density is significantly related to consumption. They argue that those living closer to alcohol outlets have drinking norms that encourage excessive consumption. Research on adolescents and university students has shown that increased availability increases the risk of alcohol consumption. Such studies have examined proximity at much smaller scales and found that consumption was higher in younger people who resided closer to an alcohol outlet in deprived areas. In New Zealand, alcohol availability, measured by density of alcohol outlets at the meshblock level, is associated with the quantity of teenage consumption (Huckle et al., 2008). Huckle et al., (2008) used driving distance of 10 minutes and delineated neighbourhoods within that range. In Switzerland, perceived availability and on-premises density was associated with volume of increased drinking (Kunstche et al., 2007), while for school, college and university students in different part of the world, , the presence of outlets was related to heavy episodic drinking (Dent et al., 2005, Kunstche and Kuendig 2005, Kuntsche et al, 2007, Kypri et al., 2008, Scribner et al., 2008, Weitzman et al., 2003a, Weitzman et al., 2003b). While the results for adolescents have been consistent, this is not the case for the adult population. Of most relevance to this research, after controlling for individual level socio-demographic characteristics, Pollack et al., (2005) found that increased access to outlets in 82 deprived neighbourhoods in California did not result in excessive alcohol consumption. Pollack calculated proximity to alcohol outlets and classified distances as either far or close. Another measure used was density of alcohol outlets generally and also within a buffer of 0.5 miles, classified as high or low density. Pollack et al., (2005) found that higher consumption may actually be in the least deprived areas.

Some studies have used natural experiments and time series to analyse changes in the availability of alcohol and consumption patterns. Natural experiments which have been largely undertaken in the Nordic countries examined changes brought about by opening of a new store where previously there was none, and the introduction of beer or wine into supermarkets. In Finland, there was a noticeable increase in beer consumption, especially for the heavy drinkers, with the introduction of outlets into rural villages and the relaxing of regulations allowing grocery stores to sell alcohol (Makela, 2002). Studies in Norway found little or no effect on alcohol consumption when there was change in alcohol outlet density (Makela, 2002). An econometric study in England investigated the effect of gradual change in alcohol outlet density on consumption using time series data from 1956 to 1980 and found affects on beer consumption, but none for wine and spirits (Godfrey, 1988).

The studies reported above show that the affect of retail access on hazardous consumption is mixed; however, there are limitations to some of these studies. Questions are raised whether the differences observed between access patterns, availability and consumption are because of the distance measures used or the population surveyed. For example, a study in California (Pollack et al., 2005) examined the general population and used geometric centroids to calculate the distance to alcohol outlets, while Huckle et al’s (2008) study of adolescents in New Zealand used population centroids. Geometric centroids calculate distances from the middle of a census tract or meshblock while population centroids calculate distances from where the population are concentrated. In addition, Huckle et al's., (2008) study was conducted in Auckland amongst a small sample of adolescents. Whether such results could be replicated in another city is unclear. Other criticisms include studies not controlling for enough individual and contextual variables to validate their results, as well as using different definitions of hazardous and/or moderate consumption.

Hay et al., (2009) and Pearce et al., (2006) recommend the use of population weighted centroids to calculate proximity to alcohol outlets, and they found that access to such outlets was better in deprived neighbourhoods. The NZHS also reports that hazardous consumption is higher in the most deprived areas. It would therefore be important to analyse if such a relationship exists, which is one aim of this thesis. Huckle et al., (2008) used driving distance within 10 minutes and delineated 'realistic' neighbourhoods, since most young people reported a travel time of 10 minutes to obtain alcohol. One benefit of this method is adjusting for speed limits which are different in rural and urban areas (Huckle et al., 2008). These New Zealand studies highlighted different ways of calculating access. For purposes of this research, the method suggested by Hay et al., (2009) and Pearce et al., (2006) was adopted.

Population groups such as university students and adolescents produced fairly consistent results, raising a further question on whether availability and access influences consumption only in homogenous groups. Studies examining retail access have been criticised for only measuring access but not the actual sales. In addition, a good public transport system means that people can easily access alcohol outlets outside their neighbourhoods. Most importantly, these studies have concentrated on examining access to bars and liquor stores and not on other outlets such as supermarkets and groceries (Jayne et al., 2008), yet there are suggestions in New Zealand that the 1999 regulation that allowed alcohol to be sold in supermarkets resulted in an overall increase in both outlets, which previously didn't sell alcohol, and consumption (Huckle et al., 2006).

Advertising and cost are suggested to be the mediating factors in the link between alcohol outlets and consumption. Since most outlets are concentrated in deprived areas, there is stiff competition and outlets need to create a demand to have a niche in the market. There are aggressive marketing strategies including dropping alcohol prices, (Babor et al., 2003) as well increasing promotions and advertisements. Promotions can include ‘buy one get one free’ or competitions where alcohol is won (Jernigan et al., 2006). There is a need to examine whether access to alcohol outlets with advertising and cost as a mediating factor in low income areas results in an increase in consumption.

3.4.3.6 Advertisement

Advertisements and marketing have been used over a long period of time to attract more people to engage in smoking, alcohol consumption and even the uptake of fast food. It is suggested that advertising may be one explanation for the patterns of alcohol consumption in deprived areas. The main targets for advertisements are people living in deprived areas, as well as non-traditional consumers such as adolescents and women. There is evidence that disproportionately higher levels of advertising occur in deprived neighbourhoods where there are more alcohol outlets. African-American and Hispanic neighbourhoods have proportionally more billboards advertising alcohol than do White or Asian neighbourhoods (Alaniz, 1998), essentially encouraging the low income communities to purchase alcohol. Similar results were observed by a longitudinal study which examined alcohol advertising around schools. There were 931 alcohol advertisements within 1500 metres of 63 schools (Pasch et al., 2007), presumably in low income neighbourhoods.

Apart from concentrating on low income neighbourhoods, most advertising also portray their brand/type of drinks as the best and the cheapest in the market. They frequently encourage promotions such as ‘happy hour’ where drinks are relatively cheap. To make people identify with the advertisements, the marketing strategies use modern, ‘eye catching’, and relevant themes to attract more consumers. Some of themes may have gender or sexual connotations, or denote camaraderie, conformity, ‘masculinity’, ‘femininity’, recreation and friendship (McCreanor et al., 2008). A qualitative study in New Zealand found that alcohol advertising and marketing strongly influenced alcohol consumption for young people aged 14-17 years (McCreanor et al., 2008). These advertisements shaped the beliefs, attitudes and behaviours of the target group (Ellickson et al., 2005, Jernigan et al., 2006, Snyder et al., 2006, Stacy et al., 2004).

While advertisement is linked to consumption, measurement is often difficult because advertisements keep changing and sometimes people do not remember them. Advertising tends to use colloquial terms that resonate well with the young people, especially females, and thus encourages consumption. There are suggestions that advertisements, especially of alcopops, a mixture of soft drink and spirits, is a major factor in the steep rise in young women's alcohol consumption (WHO, 2002). In addition, because of lack of social cohesion in most deprived and African American neighbourhoods, most advertisements are located in these areas, further exacerbating the heath behaviours (Alaniz, 1998).

3.5 Summary

Six key findings emerge from this review.

First, the issue of scale is important because the effect of contextual factors is evident at different geographical scales ranging from regional to local.

Secondly, similar to other health inequality research, there is a social and spatial patterning of alcohol consumption which cannot be wholly explained by individual factors. Features of 'place' are important in explaining some of the observed differences.

Thirdly, there is evidence that social capital and cohesion are associated with both positive and negative influences on alcohol consumption. Positive influences are protective against developing immoderate alcohol consumption when social participation is higher or there is trust in both informal and formal institutions. The strongest of the effects occurred among homogenous groups such as university students, and it has been questioned whether such influences can be extrapolated to the general community.

Fourthly, cultural context determines how, where and what one drinks. Cultures that tolerate consumption are seen to contribute to excessive consumption. Examples are cited of different drinking cultures, such as Finish culture which has strongly encouraged adolescents' consumption. Other features of culture, such as religion, are found to be a deterrent to consumption through the imposition of sanctions and norms and the provision of social support.

Fifthly, an examination of the access to and density of alcohol outlets showed a consistent social gradient with more outlets and greater access in most deprived and African American neighbourhoods. The evidence regarding the effect of outlet density and access upon consumption was inconsistent. Studies that examined homogenous groups such as university students and adolescents produced consistent results that easy availability resulted in more consumption. However, the studies on the general population showed inconsistent results with one possible explanation being the use of different techniques and methodologies, as well as different definitions and measurement of alcohol consumption patterns.

Sixth, advertising, marketing and pricing are found to be important facilitators for alcohol consumption since they are mostly targeting the aspirations and interests of those living in areas of high deprivation and high outlet density.

This contextual review has explored existing evidence of how 'place' features might contribute to alcohol consumption after controlling for the socio-demographic characteristics of individuals. Although individual factors remain important, alcohol consumption behaviour cannot be fully understood unless examined within the broader social and economic context. Such social processes include stress, availability of alcohol outlets culture, deprivation and social capital and cohesion. Much remains to be done if interventions targeting alcohol consumption are to be effective. There is a need to improve our understanding of the features of places that influence alcohol consumption and the mechanisms that link these features to individual health. Evaluating and understanding these mechanisms, through experimental studies offers an opportunity for better targeted interventions in the future (Livingston et al., 2007). More research will eventually improve our understanding of alcohol consumption and subsequent health outcomes, and in the process aid in the development of a theory underpinning 'place' studies.

3.6 Conclusion

This chapter has discussed the two aspects of the Public Health Model, the individual and the environment. It is important to note that the two are intertwined and have a relationship with the 'agent', which was discussed previously. Of greater importance is that the ways in which the three domains interact at different levels is complex, and it would be prudent to examine all of these interactions to better understand alcohol consumption and its consequences, as well enabling the formulation of policies that are all encompassing.

For individual characteristics, there is concurrence that while demographic, psychological and biological variables are important, a gap still remains, and environmental factors play an important role. For the latter environmental factors there is a dearth of research, especially studies that are intent on explanation rather than showing association, an area of interest for this study. It is particularly important to test mechanisms that explain why consumption is higher in some areas and not others. The results to date have been inconclusive and lacking in good theoretical underpinnings, so this thesis intends to investigate whether those in deprived areas consume more alcohol and, if so, whether proximity to alcohol outlets facilitates excess consumption.

Studies that examine consumption, especially hazardous consumption, have found it difficult when classifying those who drink homemade brews because the drink is illegal and therefore its consumption is under-reported. This can have the effect of portraying rural areas as safe havens when they are not, since most surrogate alcohol is brewed there. It is difficult to explain why mortality is higher in some rural areas since it has been difficult to link hazardous consumption to such locations.

Lastly, with the advent of hierarchical modelling studies it is now possible to separate the individual characteristics at one level and the environmental factors at another, therefore enabling the explanation of variation. While this review has shown that there are many contextual factors that enhance consumption, many of the issues will not be investigated, since they are beyond the scope of one thesis. This study will develop measures of access to alcohol outlets and relate these to individual data from the New Zealand Health Survey 2006/2007 using binary logistic regression modelling. The intention is to explain whether ease of access (or proximity) is a factor in deprived areas, a contextual factor that has largely been ignored in New Zealand.

The next chapter focuses on the data and the methods used to address the aim and six objectives of the thesis which were outlined at the end of chapter 1.

Chapter 4 Methods and data analysis

4.1 Introduction

The second chapter provided information on alcohol consumption, and alcohol impacts including hospitalisation mortality and crime. Chapter 3 focussed on individual and contextual explanations. Both chapters identified gaps in alcohol research. Using information from the previous two chapters, a range of quantitative analyses will be undertaken to examine the aim and objectives of the thesis. This chapter describes the data and statistical analyses undertaken to examine the main aim of the thesis, which is to determine the influence of ‘place’ effects on alcohol-related behaviour and its health and social outcomes in New Zealand. The first section of the chapter focuses on the different data sets. This is followed by a discussion of the quantitative methods used to investigate each and every objective.

4.2 Data

Five different data sets were used in this study. These are mortality and hospitalisation data, the New Zealand Health Survey (2006/07), data on alcohol outlets, census and crime data. Each will be discussed independently.

4.2.1 Alcohol Consumption data

Alcohol consumption was measured in two ways, using proxies (alcohol-related hospitalisation rates and mortality rates) and direct measurements taken from the New Zealand Health Survey.

4.2.1.1 Hospitalisation and mortality

Alcohol-related hospitalisation and mortality were selected as proxies for consumption. Proxies are defined as causes of hospital admission or death attributed directly to alcohol consumption, such as cases of toxic effects of alcohol and chronic liver disease including cirrhosis, amongst others. Not included are cases not directly attributed to alcohol including cancers of the mouth and oesophagus. Also excluded are other external causes such as road traffic or other accidents (Rehm et al., 2003b).

Similar disease codes have been used in studies in United Kingdom (Harrison and Gardiner, 1999, Breakwell et al., 2007) and Russia (Pridemore and Kim, 2006). These studies have suggested that using data directly associated with alcohol allows for comparison over time as there is no doubt that alcohol was then the cause of particular ill health or death making such data useful proxies for alcohol consumption.

In order to understand the geography of alcohol-related hospitalisation and mortality in New Zealand and determine the variation in these proxies, specific International Classification of Disease (ICD) codes for alcohol-related mortality and hospitalisations were sought from the New Zealand Health Information Service (NZHIS). The ICD is used for both mortality and hospitalisation statistics and is published by the WHO (1990), basically to enhance international comparability in the collection and presentation of health statistics. The ICD codes enable comparisons between different countries or regions. The selected (ICD) codes are shown in Table 4.1. The data includes: date of admission or of death including year, ethnicity, age, gender; the domicile code, which is used to identify the CAU in which the patient lived; and the diagnosis code.

Table 4.1: ICD 9 and ICD 10 codes (WHO 2004)

System	Type	Code	Description
ICD-9-CMA-II	A	291	Alcoholic psychoses
	A	303	Alcohol dependence syndrome
	A	3050	Alcohol use disorder
	A	4255	Alcoholic cardiomyopathy
	A	5353	Alcoholic gastritis
	A	5710	Alcoholic fatty liver
	A	5711	Acute alcoholic hepatitis
	A	5712	Alcoholic cirrhosis of liver
	A	5713	Alcoholic liver damage, unspecified
	B	980	Toxic effect of alcohol
	E	860	Accidental poisoning by alcohol, not elsewhere classified
ICD-10-AM-II	A	F10	Mental and behavioural disorders due to use of alcohol
	A	K292	Alcoholic gastritis
	A	I426	Alcoholic cardiomyopathy
	A	K70	Alcoholic liver disease
	A	K85	Acute pancreatitis
	A	K860	Alcohol-induced chronic pancreatitis
	A	K861	Other chronic pancreatitis
	B	T51	Toxic effect of alcohol
	E	X45	Accidental poisoning by and exposure to alcohol

The years for mortality data were from 1994 to 2005 while hospitalisation data were from 1999 to 2006. This was the most recent data available. When the ICD codes changed from 1999 onwards (ICD 9 to ICD 10), some new diseases, such as acute pancreatitis, became classified separately. Therefore, since hospitalisation counts are much higher, data was requested from 1999, to the latest year which was then 2006. For Mortality, since the numbers were low, data was requested from the time when ethnicity was being registered for every death. While this was said to be 1994, when data for 1994 and 1995 was inspected, ethnicity was missing. Nonetheless, data for mortality was requested from 1994-2005, which was the latest year available at the time of the research (Table 4.1). This change in ICD codes might have an impact in either increasing or reducing rates, since changeovers can result in better recording and therefore better classification. Alternatively, it might also result in other classification problems, such as under- or over-representation (Anderson et al., 2001). In New Zealand, the Ministry of Health is responsible for collecting all hospitalisation and mortality data through the NZHIS. Currently, the data from NZHIS is said to be reliable and up-to-date with the NZHIS 2002 audit saying it is up to 90% accurate.

Proxy data have their limitations. First, data for mortality and hospitalisation have domicile codes which only be used to identify CAU's and not meshblocks, the lowest geographical unit of administration. Secondly, Rehm et al., (2003) argue that special focus should be given to the volume of alcohol consumed, as well as heavy episodic drinking, both of which are important in the understanding and prevention of harm, especially at the population level. While proxy data show rates of hospitalisation and mortality, these are consequences of the time lag from the initiation of hazardous alcohol consumption until diseases are diagnosed; an improved measure would be the identification of current patterns of individual consumption. This information is available from the New Zealand Health Survey, which is described next.

4.2.1.2 New Zealand Health Survey

In addition to the proxy measures discussed above, direct measures of alcohol consumption were obtained from the New Zealand Health Survey (NZHS) 2006/07. The NZHS 2006/07 is the fourth national population-based survey undertaken in New Zealand. A total of 12,488 adults aged 15 years and over were interviewed. Amongst many other objectives the NZHS aimed to measure the health status of New

Zealanders and to measure the prevalence of the risks, associated with certain health conditions, including alcohol consumption.

The survey sampled a total of 1385 meshblocks from 32,173 census meshblocks in New Zealand. The sampling was multi-stage stratified using a probability to proportional size sampling design (PPS). The PPS design gives a high chance of selection to meshblocks containing many people as well as meshblocks that have a considerable number of Māori. The households were then randomly selected after the first random number and thereafter every k^{th} house (e.g. 5^{th}) (Ministry of Health, 2008). In choosing the household members to be interviewed a Kish grid was used, where everyone was listed and then one selected. This system ensures that everyone has an equal chance of being selected.[1]

The survey posed a range of questions about alcohol consumption. Based on the answers, the WHO AUDIT was used to separate the hazardous consumers from non-hazardous consumers (Babor et al., 2001). The questions include:

- Have you had a drink containing alcohol in the last year?
- How often do you have a drink containing alcohol?
- How many drinks containing alcohol do you have on a typical day when you are drinking?
- How often do you have six or more drinks on one occasion?
- How often during the last year have you found that you were not able to stop drinking once you had started?
- How often during the last year have you failed to do what was normally expected from you because of drinking?
- How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?

[1] ***Further information about sampling and NZHS is available at the Ministry of Health's website; A Portrait of Health: Key results for the 2006/2007 New Zealand Health Survey.***

- How often during the last year have you had a feeling of guilt or remorse after drinking?
- How often during the last year have you been unable to remember what happened the night before because you had been drinking?
- Have you or someone else been injured as a result of your drinking?
- Has a relative or friend, or a doctor or other health worker, been concerned about your drinking or suggested you cut down?

People who had a score of eight or more out of 16, (based on some questions having more weight than others) were classified as hazardous consumers. This classification was undertaken by the Ministry of Health and adopted by this study without any changes. Other alcohol consumption behaviour of interest includes frequent consumption of five or more drinks on any one occasion, whether on a weekly, monthly or daily basis, sometimes referred to as heavy episodic drinking (Dzúrová et al., 2010). The NZHS also collected socio-demographic information, including age, gender, ethnicity and socio-economic indicators of individual deprivation and personal income.

4.2.2 Alcohol outlet data

The research aims to develop and test measures of geographical access to alcohol outlets for small areas in New Zealand. The data collated is for the main alcohol supply outlets including taverns, bars, hotels, clubs, supermarkets, general stores/dairies and bottle stores for all of New Zealand. The data were sourced from the Liquor Licensing Authority, the body responsible for keeping records of all outlets in the 74 liquor licensing districts. General stores/dairies are also licensed separately by Liquor Licensing Authorities. Data for large multi-national supermarkets were collected from their WebPages as well as from telephone and business directories and verified using the online directory. The online directory is a web-based tool by various business associations and provides street addresses, therefore it was used to locate alcohol retail businesses. Table 4.2 illustrates the category of business; the source of data; the year it was collected; and total number of businesses which were geo-coded. Each category of business was sub-classified by type (on-licence or off-licence). Off-licences are defined as alcohol outlets where alcohol is bought and taken away, and include mostly bottle stores, supermarkets and general stores/dairies. On-licences are

Table 4.2: Sources of alcohol outlet data in New Zealand

Category	Source of data	Year collected	Number geo-coded
Bottle Stores	Liquor Licensing Authority, Website, business and telephone directory	2005	1002
Hotel/Taverns/Pubs		2005	4154
Supermarkets, general stores/dairies	Company website, territorial local authority, business and telephone directories	2005	960
Total			6116

defined as premises where alcohol is consumed on the premises. These are hotels, taverns, bars and clubs. However, some hotels, taverns, bars and clubs can also be classified as both on- and off-licensed premises.

In order to link the different types of outlets to their geographic location by geo-coding, information was sought that included: name; physical address; licence types (off-licence and on-licence); category of outlet (e.g. pubs, general stores/dairies, supermarkets, bottle stores).

4.2.3 Census data

In order to relate alcohol and access data to the general population and to show the geography of alcohol-related mortality and hospitalisation, census data was sought for 1996, 2001 and 2006. Since the census is undertaken only every five years, Statistics New Zealand extrapolates the data from each census to estimate probable population changes between each census. Statistics New Zealand explained extrapolation is a process that is undertaken by assuming that population increases and decreases at a constant rate (Statistics New Zealand 1997). They therefore use a mathematical formula to calculate the rates. Census data was sought for population factors such as age, gender, ethnicity, area deprivation and urban/rural location.

Age and Gender

Population estimates for age-group and gender are estimated for the whole country for the period 1994 to 2006, including the intercensal years as described above.

Ethnicity

Data was sought for intercensal years for both Māori and total population (including Māori). Census data was therefore sought for both populations for all the census years and extrapolations for the intercensal years. Statistics New Zealand explained that the estimated resident population of total population and Māori is based on the census. However, they cautioned that because the Māori population numbers in intercensal years are estimates, there are limitations and such data are supplied as a guide for research and for analytical purposes (Māori Population Estimates, 2009). According to Statistics New Zealand, because of in- and out-migration, they cannot extrapolate the population of other ethnic groups individually in the intercensal years (Joel Watkins, Population, Statistics New Zealand, personal communication) (such as Asians, Pacific Island Persons). The data sought for was therefore for total population not stratified by ethnic groups (including Māori). For Māori and non-Māori analysis therefore, the Māori estimates were subtracted from the total population estimates for the intercensal years to get the rates for non-Māori.

Area deprivation

The New Zealand Deprivation Index (NZDep) provides a deprivation score for each meshblock in New Zealand and is available in two forms, an ordinal scale and a continuous score. The NZDep ordinal score ranges from one to 10 with one representing the least deprived areas and 10 representing the most deprived. The quintiles are from one (least deprived) to five (most deprived). The index is calculated using nine variables and these are listed in Table 4.3 in order of decreasing weight (Salmond and Crampton, 2002). This data is extracted from the census and reflects aspects of material and social deprivation. NZDep data was extracted for 2001 and 2006.

Table 4.3: New Zealand deprivation variables

Dimension of Deprivation	Description of variables (proportion in small areas) in order of decreasing weight in the index
Income	People aged 18-59 receiving a means tested benefit
Employment	People aged 18-59 unemployed
Income	People living in equivalised* household with income below threshold
Communication	People with no access to a telephone
Transport	People with no access to a car
Support	People aged less than 65 in a single parent family
Qualifications	People aged 18-64 without any qualifications
Living space	People living in equivalised* household below a bedroom occupancy threshold
Owned home	People not owning their home

*Equivalisation: Methods used to control for household composition

Internationally, Kawachi and Berkman (2003) summarised the importance of area-based socio-economic measures in health inequalities. Area level SES presents measures for everyone including adolescents and women, who previously were not accounted for in SES, which is measured by the father's social status in many studies internationally. The deprivation index is therefore more comprehensive and used to cater for all ethnic groups, ages, genders, and occupational status (Krieger et al., 1997) as it reflects the economic status of an area and not an individual.

Deprivation data for all age groups and genders by area-level SES, was sought for 1994–2006 including the intercensal years. This data has been used to compare rates in deprived areas in New Zealand.

Urban/rural Location

Other census data sought includes the classification of urban and rural areas. Statistics New Zealand provided a classification of urban and rural areas, and these are divided into seven categories including the main urban areas, satellite urban areas, and independent urban areas, rural remote areas, and rural areas with low, moderate or and high urban influence (Figure 4.1). For the purposes of this research, when the numbers were low (e.g. for mortality) the areas were divided into two larger categories urban and rural with the first three categories combined into urban and the remainder combined into rural. In some cases urban was classified as main urban, secondary urban and minor urban and rural was just given one classification. Population data was sought for different age groups and genders in urban and rural areas.

Figure 4.1: Classification of urban and rural areas by Statistics New Zealand

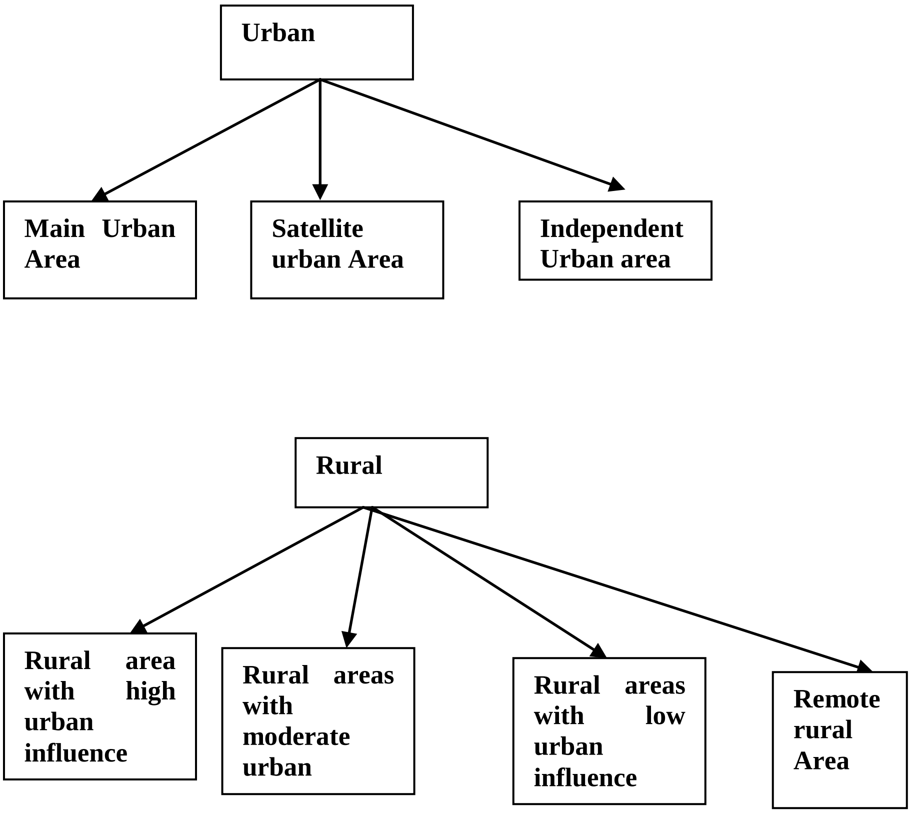


Table 4.4: Summary of census- derived variables.

Geographic area	Census variables-Total population-1994-2006
CAU	Age
Urban/ rural location	Gender
Deprived areas by quintiles	Ethnicity (Māori &all other ethnicities including Māori)

Table 4.4 presents a summary of all the derived census variables by years. For example data was sought for geographic areas including CAU level, urban /rural location and by deprivation quintiles. Additionally census variables were sought for age, gender and ethnicity for intercensal years.

Geographic Boundaries

Geographic areas are important when examining 'place' effects. In order to examine whether there are 'place' effects, the first step is to determine whether there are geographic influences on disease patterns. This is because mapping highlights areas with either higher or lower than average rates.

Many studies have discussed the problems associated with changing boundaries, in particular, the difficulty of comparing the same places in two different censuses when boundaries have changed (Martin et al., 2002). In New Zealand there has been considerable change in each census year as new areas are added to meshblocks and CAUs based on population increases. Suggestions for resolving this include choosing one geographic area and 'freezing' it over time to allow comparisons to be made (Exeter et al., 2005, Mitchell et al., 2000). For purposes of geographic analysis for this study, the CAUs of 2001 have been frozen to represent 'constant' areas within the period 1994 to 2006. This year is near the midpoint of both the periods 1999–2006 and 1994–2005, for hospitalisation and mortality data respectively. These data were assigned to each CAU in 2001 by matching the domicile with CAU codes. Six hundred records with missing geographical data were excluded from the analysis, because geographic analysis could not be undertaken when geographic details were not assigned. The aim was to map areas with higher or lower than average incidence of alcohol-related hospitalisations and mortality. Researchers suggest that mapping of incidences in small geographic areas helps with the generation of hypotheses about environmental factors that contribute to disease (Gatrell, 2002). However, for purposes of this research, the mapping is purely descriptive to show areas with higher or lower incidence of hospitalisation or mortality without necessarily investigating the geography further or generating hypotheses.

4.2.4 Crime data

Crime data was sought from the police for their 286 Police districts. This data is collated by the New Zealand Police and was obtained by the GeoHealth laboratory for the three year period from 2005 to 2007. The data includes both minor and serious violent crime such as assaults, domestic violence, homicides, robbery, unlawful assemblies and other violence related offences. This data did not have any socio-demographic information for either the victims or perpetrators of the crimes, nor was there a record of the specific geographical location where the crime occurred. The data was aggregated for all crime occurring within a police district area. These vary in size from two square kilometres to 500 square kilometres. This data was aggregated at the

Territorial Authority (TA) level and represents all crime occurring at this geographic level.

4.3 Methods

This section explains the different analytical methods used to examine the aim and objectives of the thesis.

4.3.1 Geography of alcohol consumption

As stated above in Section 1.6 the aim of this study is to determine the influence of 'place' effects on alcohol-related behaviour, and health and social outcomes in New Zealand. The first two objectives proposed to meet this aim were:

- To use available proxy measures to determine the geography of alcohol consumption in New Zealand.
- To determine the variation in the geography of these proxies by age group, gender, ethnicity, rural/urban and SES.

To examine the geography of alcohol consumption using proxies of hospitalisation and mortality, the methodology associated with each objective is presented here. Effects of alcohol consumption measured using proxies will be investigated using a similar approach, described below. Note, however, that results will be presented for morbidity and mortality (in Chapter 5).

4.3.1.1 Variation in the Geography of alcohol consumption proxies

In New Zealand, between 1999 and 2006 there were 80 342 recorded hospitalisations. The data collated for hospitalisations includes all individuals admitted to New Zealand hospitals for the selected causes irrespective of whether this a first, second or later admission; therefore some people will have been counted more than once. To avoid this, all re-admissions for each calendar year were identified by their unique National Health Information (NHI) numbers as assigned by the hospitals. They were then excluded from the analysis. Only the first admission for each person for each year was retained in the final data set.

Data for mortality and hospitalisation will be standardised in order to examine differences by age, gender and ethnicity. Standardisation is prudent when examining two or more populations of differing socio-demographics such as age, gender, and SES. If these influence hospitalisation or mortality patterns, then age standardisation eliminates the influence of the different age distribution that influences them. There are two main methods of standardisation: age-standardised rates, also known as direct standardisation; and indirect standardisation, also known as standardised mortality ratios (SMRs) (Moon and Gould, 2000). Both are similar in that they use the study population as well as the standard population, but they both have advantages and disadvantages. Both indirect and direct standardised rates were used where appropriate.

The indirect standardised rate is the rate expected in the study population if the standard populations had applied. The advantage is that it is not necessary to know the age distribution of observed cases in the study population (Moon and Gould, 2000). The disadvantage is that this method is considered to be less precise in adjusting for age especially when the age structure is different from that of the standard population. SMRs are calculated as ratios and are only valid for the study population compared to the standard population and cannot be compared with each other. An SMR which is equal to 100 implies that the mortality rate is the same as the standard mortality rate; a number higher than 100, for example 130, implies that rates are higher than expected and this would be an excess mortality rate, whereas, a number below 100 implies rates which are lower than expected (Moon and Gould, 2000). For both CAU's and TA's, indirect standardised rates were used because the number of hospitalisations and mortality for different age groups were low and directly standardising them would result in unstable estimates (Moon and Gould, 2000). There are many zero counts of hospitalisation and mortality per CAU since some age groups stratified by gender did not have any admissions or mortality for all the different years.

Direct standardisation in an area is used to determine the number of alcohol related admissions that would occur if the area had the same age structure as the standard population and the local age-specific rates of the areas applied (Moon and Gould, 2000). Direct standardisation has been used in many studies because it allows different sub-populations to be compared since they are standardised against one population. It is therefore important to use a standard population that compares to the population structure of the study population. For this project the population chosen was the total New Zealand population in 2001. Table 4.5 illustrates that the chosen 2001 population age structure is very similar to the patterns evident in 1996 and 2006. Studies worldwide have used the world population developed by the WHO (Ahmad et al., 2000) or the SEGI (Segi, 1950) population but their structures are said to be different from New Zealand and therefore give an over- or under-representation. Such anomalies have implications for health policy (Robson et al., 2007b). When comparing countries around the world, it is prudent to use the standard WHO world population.

Table 4.5: Proportion of New Zealand population in each age group by different census years

	1996	**2001**	**2006**
Age groups		**Population proportion**	
0-14	0.24	0.23	0.21
15-24	0.15	0.14	0.15
25-34	0.16	0.14	0.13
35-44	0.15	0.16	0.15
45-54	0.12	0.13	0.14
55-64	0.08	0.09	0.11
64+	0.10	0.12	0.12
	1.0	**1.0**	**1.0**

Using the census data for age and gender extrapolated for the intercensal years, standardised rates for alcohol-related mortality and hospitalisation were calculated for each year. Five cases which had no data for gender were omitted from the analysis.

The calculation of age-standardised rates involved two processes; first, age specific incidence rates (ASIR) were calculated for all age groups stratified by gender for each year. ASIRs are calculated by dividing the number of observed cases within each age group for each year, by the total population for the same year and multiplying by 100 000 to give the ASIRs per 100 000 population.

$$ASIRs = \frac{\text{observed cases (age group)}}{\text{total population (age group)}} \times 100\,000$$

Secondly, age specific standardised rates were calculated by multiplying the ASIRs by proportion of the age group in the population (Table 4.5)

$$Age\ standardised\ rates = ASIR \times proportion\ of\ population\ in\ age\ group$$

For ethnicity, Māori and non-Māori rates are calculated separately. All data with missing ethnicity information were omitted from the analysis which resulted in a total of 283 deaths being omitted from the ethnicity analysis. The above calculation was also repeated for the population in deprived quintiles and urban/rural areas by age group and gender.

Confidence intervals were calculated using Byar's approximation of the exact Poisson distribution, suggested to be accurate even with small numbers (Breslow and Day, 1987). Byar’s method has been used by Washington State Department of Health (2010) and the New York State Department of Health (2010), amongst other studies calculating confidence intervals. The following formula was used.

$$SIR_L = SIR\left(1 - \frac{1}{9O} - \frac{Z_{\alpha/2}}{\sqrt{3O}}\right)^3$$

$$SIR_U = SIR\left(\frac{O+1}{O}\right)\left(1 - \frac{1}{9(O+1)} + \frac{Z_{\alpha/2}}{\sqrt{3(O+1)}}\right)^3$$

SIR-Age Standardised rates (lower and upper CIs)
O-Observed count of cases
$Z_{a/2}$ = Value of the standard normal distribution for a given significance level (alpha). (For a 95% confidence interval alpha = 0.05 and $Z_{a/2}$ =1.96)

The results are presented in bar and line graphs for age, gender, ethnicity, urban/rural and deprivation illustrating temporal trends over time as follows:

- Hospitalisation and mortality temporal trends by age and gender in Chapter 5
- Hospitalisation and mortality temporal trends by ethnicity, by age and gender in Chapter 5
- Hospitalisation and mortality temporal trends by deprivation, by age and gender in Chapter 5
- Hospitalisation and mortality temporal trends by urban/rural location, by age and gender in Chapter 5

4.3.1.2 Geographical patterns

Determining whether or not there is a geographical pattern of alcohol-related hospitalisations and mortality at the TA level involved calculating indirect standardised rates in three steps.

The first step was to calculate the ASIR. This was done by dividing the number of observed cases within each age group in the whole country, for the whole period, by the population and multiplying by 100 000 to give the ASIRs per 100 000 population.

$$ASIRs = \frac{\text{observed cases (age group)}}{\text{total population (age group)}} \times 100\,000$$

After calculating ASIRs, they were multiplied by the corresponding population. The next step was to calculate expected rates. The total population was divided by 100 000 and then multiplied by the ASIR to give the expected rates for each age group in the TA, and then summed up for all age groups.

$$Expected = \frac{total\ population}{100\,000} \times ASIR$$

The third step was to calculate the standardised rate. This was undertaken by using the observed rates per TA, divided by the expected rates, and multiplied by 100 to get the age-standardised rates.

$$Age\ standardised\ rates = \frac{Observed}{Expected} \times 100$$

The result was interpreted as follows. If the SIR is equal to 100, the study population had the same risk of disease as the standard population. This shows that the observed number of cases is equal to that expected. However, if the SIR is greater than 100, then the study area’s incidence is greater than that of the standard population and vice versa if SIR is less than 100. This shows that incidence is lower than that of the standard population (Moon et al., 2000).

The resulting standardised rates were then mapped in a GIS and were used to identify areas that had higher or lower than average rates.

4.3.1.3 Predicting mortality/hospitalisation trends by deprivation after controlling for confounding factors

The previous methodology focused on the descriptive analysis of individual factors, standardising mortality and hospitalisation rates and the investigation of geographical differences at the TA level. This section now focuses on predicting mortality and hospitalisation trends after controlling for potential confounding factors. The first analysis was mostly descriptive and indicated temporal and geographic trends. To verify whether these relationships remain after controlling for other potential confounding variables, Poisson regression analysis was undertaken. Poisson regression modelling is widely used in most epidemiological observational prospective studies, since it estimates the occurrence of disease in both exposed and unexposed subjects. Poisson regression was chosen because it is a useful technique when modelling dependent variables that describe count data (Fox, 2008). Poisson regression is therefore basic count regression modelling and is normally applied in studies where the number of observed cases are small (Hair et al., 2006) as was in this study. Poisson regression is used to estimate the differences in incidence rate ratios (IRRs) between different groups and to understand whether the explanatory variables influence the rates of the disease in question. The goal of this research is to determine whether alcohol-related hospitalisation has an association with area deprivation, after adjusting for potential confounding variables. To analyse whether deprivation has an influence after controlling for other variables (age, gender and urban/rural location) all CAUs were assigned to a deprivation quintile and ***raw counts*** of the number of hospitalisation and mortality cases were extracted for quintiles of deprivation by age group, gender and urban rural location for all the years. The exposure variable was raw count of population, by age group, gender and rural/urban location for each deprivation quintiles. In this study, the models for hospitalisation and mortality have been run for two different periods: mortality 1994–1999 and 2000–2005; hospitalisation 1999–2002 and 2003–2006.

In order to examine the relationship between alcohol-related hospitalisation and mortality and area deprivation, the Poisson regression involved the following steps;

- baseline model –NZ deprivation
- gender and age

- urban/rural location
- ethnicity.

As indicated in Table 4.6 the baseline model only includes NZ deprivation, which is the main study factor. In the baseline model, the dependent variables (either hospitalisation or mortality) and their relationship with deprivation were estimated in regression. All other potential confounding variables were added sequentially, starting with age and gender in the first model, urban/ rural location in the second and ethnicity (percentage of European ethnicity) in the third. Changes were observed on the deprivation quintiles from baseline and as control variables were added sequentially. All the confounding variables were chosen based on the literature reviewed which showed differing rates in hospitalisation by age, gender, ethnicity and location. The results for Poisson regression are interpreted based on the differences compared with the baseline group. For example, in the baseline model, Quintile 1 is the reference group, and the IRRs are observed for all the different quintiles. If the IRRs for Q2 > 1 then the rate for Q2 > Q1 otherwise if Q2 < 1 then Q2 < Q1. With hospitalisation or mortality as the dependent variables, a gradient is expected with increasing IRR's as deprivation increases. The change in IRR's for the deprivation quintiles are monitored as the potential confounding variables are adjusted for.

Tables 4.7 and 4.8 illustrate the distribution of dependent, independent and confounding variables for hospitalisation and mortality for the whole period for CAUs. The two tables show the minimum, maximum, mean and standard deviations. For example some CAUs had no cases of hospitalisation, while others had as many as 21 cases. For Mortality, the highest number of cases per CAU did not exceed 2. Additionally, low standard deviation means that the variables are not widely dispersed. Moreover, high standard deviation would make Poisson regression estimates unreliable. In addition, the distribution of the different variables shows that the mean is closer to zero, except for total population and percentage ethnicity.

Table 4.6: Model for Poisson regression on alcohol-related proxies

Baseline: NZ deprivation	**Model 1: Gender/Age**	**Model 2: Rural/urban**	**Model 3: Ethnicity**
Exposure variable-Population	Exposure variable-Population	Exposure variable-Population	Exposure variable-Population
Raw counts of hospitalisation/mortality	Raw counts of hospitalisation/mortality	Raw counts of hospitalisation/mortality	Raw counts of hospitalisation/mortality
Quintile 1 Quintile 2 Quintile 3 Quintile 4 Quintile 5	Quintile 1 Quintile 2 Quintile 3 Quintile 4 Quintile 5	Quintile 1 Quintile 2 Quintile 3 Quintile 4 Quintile 5	Quintile 1 Quintile 2 Quintile 3 Quintile 4 Quintile 5
	Gender Female Male	Gender Female Male	Gender Female Male
	Age groups 65+ 55-64 45-54 35-44 25-34 15-24 0-14	Age groups 65+ 55-64 45-54 35-44 25-34 15-24 0-14	Age groups 65+ 55-64 45-54 35-44 25-34 15-24 0-14
		Urban Rural	Urban Rural
			% European Ethnicity

Table 4.7: Descriptive statistics for variables used in hospitalisation analysis (1999-2006)

elbairaV	muminiM	mumixaM	naeM	Standard Deviation
Hospitalisation counts				
Urban	0	21	0.4	0.8
Rural	0	5	0.1	0.3
Control variables				
Age				
0-14years	0	3	0.0	0.2
15-24years	0	21	0.5	1.0
25-34years	0	18	0.4	0.8
35-44years	0	19	0.4	0.8
45-54years	0	12	0.3	0.7
55-64years	0	11	0.2	0.6
65+years	0	11	0.3	0.7
Gender				
Males	0	15	0.2	0.5
Females	0	21	0.4	0.9
Area Deprivation				
Quintile 1 least deprived	0	9	0.2	0.4
Quintile 2	0	19	0.2	0.6
Quintile 3	0	21	0.3	0.7
Quintile 4	0	11	0.4	0.8
Quintile 5 most deprived	0	19	0.5	1.0
Ethnicity				
Percentage European	7.6	100	73.9	17.8
Exposure Variable				
Total population	1	2 121	165.4	140.4

Table 4.8: Descriptive statistics for variables used in Mortality analysis (1994-2005)

elbairaV	muminiM	mumixaM	naeM	Standard Deviation
Mortality counts				
Urban	0	2	0.01	0.1
Rural	0	2	0	0.1
Control variables				
Age				
0-14years	0	0	0	0
15-24years	0	1	0	0.03
25-34years	0	1	0	0.04
35-44years	0	2	0	0.06
45-54years	0	2	0.01	0.09
55-64years	0	2	0.01	0.1
65+years	0	2	0.01	0.1
Gender				
Males	0	2	0	0.09
Females	0	2	0.01	0.06
Area Deprivation				
Quintile 1 least deprived	0	2	0	0.05
Quintile 2	0	2	0	0.07
Quintile 3	0	2	0.01	0.07
Quintile 4	0	2	0.01	0.09
Quintile 5 most deprived	0	2	0.01	0.1
Ethnicity				
Percentage European	7.6	100	73.9	17.8
Exposure Variable				
Total population	1	2 121	165.4	140.4

4.3.2 Access to alcohol outlets

This section addresses the third objective of the thesis which is shown in Section 1.6 above as: *"To develop and test measures of access to alcohol outlets (off-site and on-site) for small areas across New Zealand".* As mentioned in the literature, access to alcohol outlets has been suggested as one way in which researchers can find explanatory reasons for hazardous consumption in the most deprived areas compared to least deprived areas. Section 4.3.2.1 below discusses geo-coding and how the different access measures were derived. Section 4.3.2.2 examines the distribution of the developed measures in different geographic areas of varying scales. The aim was to see if a social gradient existed and whether there were variations at different geographic locations. The four research questions to be addressed are:

- Is there a relationship between access to alcohol outlets and deprivation in small areas in New Zealand?
- Is there a relationship between density of alcohol outlets and deprivation in New Zealand?
- Does the relationship between access to alcohol outlets and deprivation vary by urban/rural location in New Zealand?
- Does the relationship between access to alcohol outlets and deprivation vary within the 16 administrative regions in New Zealand?

4.3.2.1 Geo-coding

Geo-coding is the process of associating descriptive data with fixed geographic points for the purpose of correlating events with the location. The process includes assigning geographic coordinates to street addresses as well as to other points and features. With geographic coordinates, the features can then be mapped and entered into GIS (Apparacio et al., 2008). Once the data on alcohol outlets and their addresses had been collected, it was run through batch geo-coding and most of the outlets matched automatically. A random check was undertaken of 200 outlets to examine whether the batch coding was accurate. For those alcohol outlets that could not be matched, either because the addresses were different, were incorrectly spelled or missing, the correct addresses and spelling were located using Google maps, Google search, Smaps, and telephone and business directories. Interactive geo-coding was undertaken for outlets that were not matched by batch geo-coding. In cases where the address was not a complete match, some were able to be matched to a neighbouring address. For example, if the correct address was 17 Ilam Road and this could not be traced in the geo-coding system the address was changed to 19 Ilam Road. About 15 addresses were geo-coded in this way since the research is more focussed on location/place than specific point data.

The total number of alcohol outlets in New Zealand in 2006 was 6213. A total of 6116 outlets were successfully geo-coded either interactively or by batch geo-coding, with a success rate of 98% (Table 4.9). An earlier study using similar data in New Zealand, which focused on examining outlets within the main urban areas, successfully geo-coded 95% of alcohol outlets (Pearce et al., 2008a).

Table 4.9: Alcohol outlets by category in New Zealand

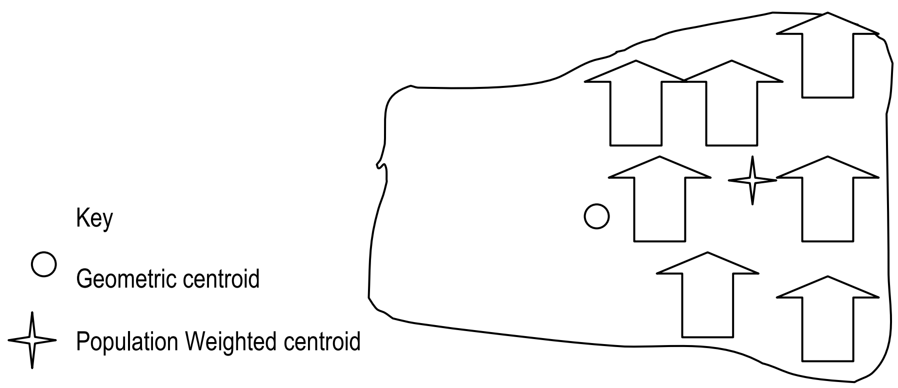
Category	**Number geo-coded**
Bottle Stores	1002
Hotel/Taverns/Bars	4154
Supermarkets/ General stores/dairies	960
Total	6116

After geo-coding, the meshblocks in which the alcohol outlets were located were identified. There are approximately 38 350 meshblocks in New Zealand (NZ Census 2006). A meshblock is the smallest unit of dissemination in the New Zealand census and has a total population of approximately 100 people and ranges in size between $1000m^2$ to $2200km^2$. As indicated earlier in Chapter 3, to calculate distances from population weighted centroids, the outlets were linked to meshblocks (the smallest geographical unit in NZ). This methodology has been both adopted and recommended in other studies (Hay et al., 2009, Pearce et al., 2008)

4.3.2.2 Measuring access to alcohol outlets

The first stage of the analysis involved calculating the nearest distance to alcohol outlets within meshblocks. Analysis was undertaken to calculate the least cost distance to the nearest alcohol outlets. Using GIS, the road network in New Zealand was added to the data on alcohol outlets. Each meshblock was represented by a population-weighted centroid, calculated as a point reflecting the average location of population in an area (Figure 4.1). For New Zealand, a population-weighted centroid is calculated at the meshblock level in ArcGIS. They are suggested to accurately represent the geographic distribution of households where the population is located rather than geometric centroids. Geometric centroids are mostly located at the centre of the meshblocks and are sometimes far from where the population is (Pearce et al., 2007a). From the centroid, travel distance to the nearest alcohol outlet is calculated with network functionality in ArcGIS using distance along road segments adjusted to account for variations in sinuosity and topography. The suggested method is not very complex and involves calculating travel distance through a road network (Pearce et al., 2006). The measures developed include distance to the nearest alcohol outlets in metres. Travel distance was calculated for all the 38 000 meshblocks. This data was exported to SPSS and further analysis included calculating median distances to alcohol outlets within certain geographical areas stratified by deprivation. The aim was to answer the question on whether proximity to outlets varies by deprivation in different localities.

Figure 4.2: Schematic diagram of a mesh block with seven houses with the key showing the population-weighted centroid and geometric centroid.

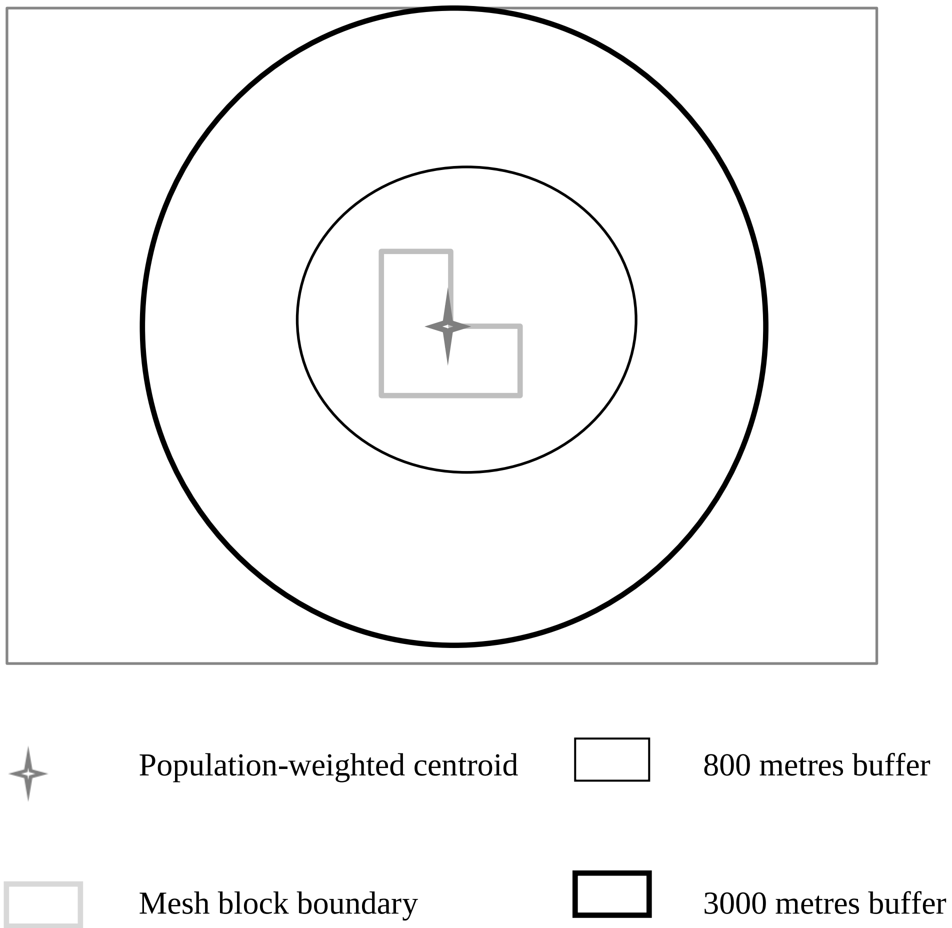


The second step involved deriving density measures of outlets within buffers of 800 metres and 3000 metres, denoted as walking and driving distances of 10 minutes respectively. According to Pearce et al. (2008a), few studies internationally have used buffers to calculate travel time; however, buffers are important because the sphere of influence of each outlet often extends beyond the meshblock boundary. In other words, people can walk or drive to alcohol outlets and not necessarily stay within the meshblock boundaries. Both the 800 and 3000 metre buffers have been used in other studies (Pearce et al., 2008a) and were suggested to be appropriate in a recent study that examined youth alcohol consumption (Pasch et al., 2009) and physical activity (Boone-Heinonen et al., 2010).

Joseph and Phillips (Joseph and Phillips, 1984) acknowledged difficulties with access measures and recommended that regional measures should take into account consumer behaviour patterns. While they concentrated on access to health services, later studies were more interested in spatial distribution of resources; however, there was a general lack of reason as to how the distances to retail outlets were calculated (Quoted from Joseph and Phillips 1984). Joseph and Phillips (1984) suggested that heterogeneity must be taken into account when calculating distances and that when large geographical areas such as census tracts or TAs were used, important area differences were obscured. This is compounded when people of different income, social class, age, gender, and ethnicity live in the same areas. A number of studies have tried to define access using a variety of measures, over and above the direct distance measures to amenities. Talen and Anselin (1998) used the phrase ‘coverage method’ to define the number of amenities within a certain radius around a neighbourhood. Their argument was that there could be many amenities within a close distance that people could go to, not just one. In addition there are paths or side roads that could lead to the amenities, without necessarily following the main roads. Pearce et al. (2008) add that the sphere of influence of outlets may spread over and above recognised administrative boundaries and therefore it is important to cover the complete catchment area and they recommended using a buffer of 3000 metres. Buffers are therefore used to denote residents’ neighbourhoods plus areas in the adjacent neighbourhoods. Most studies have used 800 metre buffers (Smiley et al., 2010, Spence et al., 2009) to denote walking distance and 3000 metre buffers to denote driving distance (Donkin et al., 2000) with recommendations that two mile buffers (approximately three kilometres) denote a reasonable driving distance to fast food (Donkin et al., 2000) and even to alcohol outlets (Pasch et al., 2009). Access measures of 3000 metres and 800 metres have been used in this study based on the recommendations of previous research.

Using GIS, two buffers were created around the population-weighted centroids of each meshblock. Some studies have suggested that Euclidean distance is correlated to road network distance and is appropriate (Apparacio et al., 2008). Apparacio (2008) suggests that using road networks to calculate distances within the buffers of 800 metres or 3000 metres is complex and requires much computational time. Similarly, studies that compute time within networks also require much computational time and are fairly complex (Brabyn and Skelly, 2002). Measures for the walking and driving distances for this study were calculated. A straight line Euclidean distance from each population-weighted centroid was calculated for all alcohol outlets, including (type) on- and off-licence, (category) supermarkets and general stores/dairies, hotels, bars, taverns and bottle stores. A schematic diagram of buffer measure is illustrated in Figure 4.2. These analyses were carried out in ESRI ArcGIS 9.1 software using the network analyst function.

Figure 4.3: Schematic diagram of meshblock and buffers from population-weighted centroid



The measures developed were (i) density of all alcohol outlets within an 800 metre radius of each meshblock centroid (assumed to be the walking distance) and (ii) density of all alcohol outlets within 3000 metres radius (assumed to be driving distance). The distance and density measures developed are continuous. However, for confidentiality purposes in order to access the NZHS survey, they were changed to category variables using SPSS. For distance measures, the variables were stratified into four quartiles, ranging from the nearest to the furthest with each of the groups having approximately 9960 meshblocks. These were classified from the closest (less than 571 metres) to the furthest away (over 2.2 kilometres) from an alcohol outlet. The densities of outlets within 800 and 3000 metres were skewed and could not be divided into four equal quartiles. There were 41% of meshblocks without an outlet within 800 metres, compared to only 16% for 3000 metres. The number of outlets within 800 metres ranged from 1–196, and was divided into four unequal parts, with neighbourhoods with no outlet forming approximately 41% and the rest (1–2 outlets, 3–6 and 7+) at roughly 20% each. The number of neighbourhoods with outlets within 3000 metres ranged from 1–422, with neighbourhoods with no outlets forming approximately 16% and the rest each at 28% each (1–13 outlets, 14–37, and 38+).

Finally, the developed access measures were saved in an Excel file and sent to the Ministry of Health for the NZHS (2006/2007) data to be appended. Table 4.10 summarises the access measures.

Table 4.10: Summary of access measures

Variable	Alcohol accessibility
Nearest distance to alcohol outlets	Nearest distance to all alcohol outlets
Density of alcohol outlets within 800 metres buffer	Number of all alcohol outlets within a walking distance
Density of Alcohol outlets within 3000 metres buffer	Number of all alcohol outlets within a driving distance

An initial literature review suggested that there are more alcohol outlets in socially deprived neighbourhoods both internationally (LaVeist and Wallace, 2000, Pollack et al., 2005) and in New Zealand (Pearce et al., 2008a). Researchers have suggested that it is important to understand the location of different types of outlets as they are 'hot spots' for different kinds of behaviour (Block and Block, 1995, Roncek and Bell, 1981, Roncek and Maier, 1991, Sherman et al., 1989). This study therefore tested measures of access to, and density of alcohol outlets to examine if they were consistent with both local and international literature. The distributions of access and density measures were estimated against area deprivation, urban/rural classification and by regions.

During geocoding, all alcohol outlets were appended to meshblocks which were then assigned the census variables including area deprivation quintiles, urban/rural location and regions. Using the New Zealand 2006 census, the number of alcohol outlets in different deprivation quintiles for the whole of New Zealand was calculated. This was undertaken by calculating the number of alcohol outlets within deprivation quintiles and dividing by the total population within that quintile and then multiplying by 10 000 to get the rates.

$$outlet\ denisty\ per\ 10\ 000 = \frac{number\ of\ alcohol\ outlets}{total\ population\ in\ deprivation\ quintile} \times 10\ 000$$

This analysis was stratified by the different categories and types of outlets. For this analysis, there were six outlets that were located in meshblocks that were not assigned a deprivation index and were excluded from the analysis. Further distribution analyses for both distance and density measures were undertaken in three steps. First, the distribution of alcohol outlets in deprivation quintiles by distance and density, stratified by type and category, was undertaken in SPSS. This analysis investigated whether or not there was a gradient, by highlighting neighbourhoods with longer and shorter median distances and how they were distributed in each deprivation quintile. Similarly for density, the number of outlets within each buffer and how they were distributed within each deprivation quintile was investigated. Next, rate ratios between quintile five and one were calculated. Ratios were calculated to highlight the differences between two different quintiles, in effect, showing how deprived neighbourhoods differ in access and density. Rate ratios were calculated by dividing rates in quintile five and quintile one. Chi square tests (χ^2) were then used to test the association between category variables, such as distances and deprivation quintiles.

These same analyses were undertaken for urban/rural location, the 16 regions and then New Zealand as a whole, stratified by deprivation (Table 4.11). The analyses aimed to show variations at different geographical levels. All these analyses were undertaken in SPSS 16, STATA 10.2 and Excel. For urban/rural locations where possible, analyses were further stratified by the seven categories of rural and urban location.

Table 4.11: Summary of the distribution and statistical analysis for alcohol outlets

	Access and density measures			Analysis		
Geographic regions	Distance to alcohol outlets and Median distance	Density of outlets within 800metres buffer	Density of outlets within 300 metres buffer	Rates of outlets per 10,000 population	Rate ratios: difference between quintile 5 and 1	χ^2 test
Deprived areas	√	√	√	√	√	√
Urban/Rural: stratified by deprivation quintiles	√	√	√	√	√	√
Regions: stratified by deprivation quintiles	√	√	√	√	√	×

Key: √ Analyses undertaken × Analysis not undertaken

4.3.3 Access to alcohol outlets and alcohol consumption

The fourth and main objective of this thesis is *to determine whether access to alcohol outlets makes an independent contribution to alcohol consumption after controlling for potential confounding factors.*

To achieve the fourth aim, two questions were examined:

- Does living closer to alcohol outlets make an independent contribution to hazardous alcohol consumption/heavy episodic drinking after controlling for potential confounding individual and area level variables?

- Is living closer to alcohol outlets associated with a greater likelihood of frequent consumption of five or more drinks in the last 12 months, after controlling for potential confounding individual and area level variables?

As previously explained in Section 4.2.1.2, the data used to achieve the objective was derived from the New Zealand Health Survey of 2006/07. Several further sub-questions were used as a guide in achieving this objective. Similar questions were asked for both hazardous consumption and heavy episodic drinking.

The questions were;

- Does proximity to, and geographic density of, alcohol outlets vary by individual socio-economic status?
- Do residents living in deprived neighbourhoods have increased odds of hazardous or frequent alcohol consumption?
- Do residents living in neighbourhoods that are closer to alcohol outlets have increased odds of hazardous and frequent alcohol consumption?
- Do residents living in neighbourhoods with a higher density of alcohol outlets (walking distance - 800 metres) have increased odds of hazardous or frequent alcohol consumption?
- Do residents living in neighbourhoods with higher density of alcohol outlets (driving distance - 3000 metres) have increased odds of hazardous or frequent alcohol consumption?

4.3.3.1 Access measures appended to the NZHS survey

To satisfy ethical confidentiality requirements, all independent variables in the data set were categorical rather than continuous variables. Other confidentiality requirements included illustrating that there were no unique meshblocks identifiable by a combination of distance, urban/rural location and deprivation variables. All 20 unique meshblocks that were identifiable were deleted from the data set. Suffice it to say that the research focussed on analysing data at a much finer level by separating the different outlets by category and type, as well as by different geographical levels such as CAUs, TAs, District Health Boards (DHBs) and regions. For confidentiality reasons this was not possible, since further stratifying the access variables resulted in many meshblocks being identifiable. The final access measures therefore consisted of only three variables of proximity to alcohol outlets and two other variables, area deprivation and urban/rural location. Once the access measures were developed, the developed measures were sent to the Ministry of Health and appended to the NZHS (2006/07) data set. The variables derived from the NZHS are highlighted in Table 4.12.

Table 4.12: Alcohol consumption behaviour derived from the New Zealand Health Survey 2006/07

Analysis	Alcohol behaviour dependent variable
Hazardous consumers/heavy episodic drinkers	AUDIT classification of hazardous consumers; A score of 8 or more
Consumption of 5 drinks or more monthly, weekly or daily	Those who consume five or more drinks frequently

Two outcome measures of alcohol-related consumption behaviour were used in the analysis. The first, hazardous consumption was classified by the Ministry using the AUDIT score. The second was frequent consumption of five or more drinks on one occasion within the last year. The survey asked respondents how frequently they consumed five drinks or more on one occasion with possible answers ranging from; 1- never; 2 - less than monthly; 3 - monthly; 4 - weekly; and 5 - daily. Consequently, to combine all responses into a binary form, a histogram was developed. Table 4.13 illustrates the histogram of frequency of consuming five or more drinks. Based on the percentages, the NZHS options three, four and five above were chosen to represent frequent consumption of five or more drinks. These were compared with options one and two which represent infrequent consumption in line with the methods used in other studies to estimate heavy episodic drinking (Dzúrová et al., 2010).

Table 4.13: Percentage of frequent consumption of five or more drinks

Frequency of consumption	Percentage
1 - Never	49.0
2 - Less than monthly	24.8
3 - Monthly	13.5
4 - Weekly	11.8
5 - Daily	1.0

4.3.3.2 Confounding variables

There are several covariates mentioned in the literature review (see Chapters 2 and 3 above) which were selected for inclusion in the models. These compositional and contextual variables have a relationship with alcohol consumption and include age, gender, ethnicity, personal income, individual deprivation, urban/rural location and area deprivation. These were all selected because of their possible role as confounders as explained above. All individual variables were derived from the NZHS (2006/07), while the two contextual factors, urban/rural location and area deprivation were derived from the 2006 census. To establish that contextual factors are important, research must be able to control for potential confounding variables and still have a significant relationship.

Most studies have shown that alcohol consumption is concentrated in the younger age groups, particularly amongst males. In order to examine whether distance to alcohol outlets influences consumption, it is important to control for age and gender. Similarly since certain ethnic groups are heavy consumers of alcohol, it is important to control for ethnicity. For individual SES, alcohol studies show mixed results with some showing higher rates of hazardous drinking among more affluent groups, and others the reverse. Nevertheless, in this study controls were made for two measures of socio-economic status; personal income and individual deprivation. Personal income was divided into four categories as per the NZHS: $0–20,000; $20,001–40,000; $40,001–80,000 and > $80,001. Individual deprivation was based on a scale ranging from individuals reporting no deprivation, to those reporting multiple forms of deprivation. The NZDep's main aim is "identify a small set of indicators of an individual's deprivation that is appropriate for all ethnic groups and can be combined into a single and simple index of individual socioeconomic deprivation" (Salmond et al., 2007, pg 1). The index therefore measures socio-economic position of individuals without considering occupational status. The index uses eight questions and based on the answers, one can fall in the five categories, ranging from no deprivation characteristics to five deprivation characteristics (Salmond et al., 2007). The census variables controlled for were urban/rural location and area deprivation. Most studies have shown that area deprivation has an effect on health over and above individual factors, therefore, it is important to control for this factor in the analysis. Alcohol consumption is related to urban/rural location so controls for the latter were also necessary since accessibility varies markedly among urban and rural meshblocks. Controlling for all these variables therefore makes this study comparable to other studies that examine the effect of neighbourhoods on health (Do and Finch, 2008, Pickett and Pearl, 2001).

4.3.3.3 Analytical approach

Since the Ministry of Health had reported on the characteristics of the sample population as well as alcohol consumption patterns from NZHS 2006/07, some basic descriptive analysis was undertaken for both exposure (alcohol outlets) and outcome (alcohol consumption) variables in order to determine their distribution. All category variables were tested by chi square. Chi square tests indicate whether or not the distributions are dependent on each other, or whether they occur by chance and are independent of each other (Alati et al., 2010). Descriptive analysis highlights the distribution of both exposure (access measures) and outcome variables amongst individual characteristics separated by age, gender, ethnicity, personal income and individual deprivation. Additionally, distribution is examined amongst groups stratified by deprivation quintiles and urban/rural.

This study aims to determine the independent effect of proximity to alcohol outlets, measured in a number of ways, and its association with alcohol-related individual behaviour from the New Zealand Health Survey. Since this is multi-level data comprising both neighbourhood and individual measurements, a series of binary logistic regression models have been estimated. A number of studies have used binary logistic regression methods when examining data that is at two levels (for example: Burdette and Hill, 2008, Coombes et al., 2010, Ek et al., 2008, Zhang et al., 2010). Most importantly, this technique was adopted on the advice of Prof Graham Bentham (personal communication). Regression analyses demonstrate the degree to which one or more variables potentially promote positive or negative change in another variable. There are two basic reasons why regression analysis should be used. The first is to model some phenomena to gain a better understanding of their interactions and thus provide a sound basis from which to effect policy change. The second reason is to test hypotheses, for example, whether access to alcohol outlets influences consumption after controlling for a range of potential confounding variables (Wooldridge, 2003, Hamilton, 1992).

Table 4.14: Analysis structure with access variables as exposure, and alcohol-related behaviour as a dependent variable

		Hazardous consumption	**Frequent consumption**
Distance measures	**Binary logistic regression**	(n=9980) 0 = Non-Haz 1= Haz	(n=10 012) 0 = Non Freq 5 1 = Freq 5
Nearest distance to alcohol outlet	**National**		
	Whole population	√	√
1 = 0–571m	**Sub-Population**		
2 = 572m–995m	Age and Gender	√	√
3 = 996–2160m	Ethnicity, age and gender	√	√
4 = >2161m	**Rural urban**		
	Whole Population	√	√
	Age and gender	√	√
Density measures			
Buffers of 800 metres	**National**		
0 = No outlet	Whole population	√	√
1 = 1–2 outlets	**Sub-Population**		
2 = 3–6 outlets	Age and Gender	√	√
3 = >7 outlets	Ethnicity, age and gender	√	√
	Rural urban		
	Whole Population	√	√
	Age and gender	√	√
Buffers of 3000 metres	**National**		
0 = No outlet	Whole population	√	√
1 = 1–13 outlets	**Sub-Population**		
2 = 14–37 outlets	Age and Gender	√	√
3 = >38 outlets	Ethnicity, age and gender	√	√
	Rural urban		
	Whole Population	√	√
	Age and gender	√	√

Key: √ = Analyses undertaken
Non-Haz = Non-hazardous consumption - AUDIT score less than 8.
Haz = Hazardous consumption - AUDIT score of 8 or more.
Non- Freq 5 = consuming 5 drinks or more (consumed on one occasion) less than once a month or never
Freq 5 = consuming 5 drinks or more (consumed on one occasion) monthly, weekly or daily

Binary logistic analysis was used to examine the association between the exposure variables, proximity to alcohol outlets and two outcome variables: hazardous consumption and frequent consumption of five or more drinks (monthly, weekly or daily) (Table 4.14). The analysis was repeated for exposure variables with buffers of 800 metres and 3000 metres. For this analysis, alcohol consumption behaviour, which includes hazardous consumption, measured at individual level was nested within neighbourhoods. The analysis was conducted for the whole country and then stratified by age, gender, ethnicity and urban/rural location.

Binary logistic regression is used to report ORs, where distance is the exposure variable explaining dependent alcohol-related behaviour. The OR is used to assess the risk of a particular outcome, (alcohol-related behaviour) if a certain exposure (better access to alcohol outlet), is present. The OR indicates how much more someone exposed to shorter travel distances will consume alcohol hazardously or drink more frequently. For example, in the baseline model, the nearest distance (<571m) is the reference group, and ORs are observed for all the different distances. When the OR exceeds one, then there is a positive association but there is a negative association if consumption decreases as distance increases, or when OR is less than one. This study expects that as distance increases, consumptions deceases. For density measures the expectation is a positive association in which consumption increases as density increases.

Tests of trends for exposure variables are undertaken by fitting the category variables as continuous measures while examining whether the p-value was statistically significant ($p < 0.05$). Tests of trends are important where the binary response in ordered categories is of interest, since it shows whether the change is in a sequence or not (Zhang et al., 2010). For example, when analysing access to alcohol outlets, tests of trends indicate whether consumption decreases sequentially as distance to alcohol outlets increases, in effect examining whether there is a gradient and the direction of that gradient, if it exists.

Binary logistics analysis was undertaken in STATA 10.1. The survey was complex in nature but STATA has functions that take the survey design into consideration. The survey design includes clusters, a stratum used for sampling purposes and final weights assigned for each respondent. It is important to account for sample design so as to yield accurate estimated standard errors of parameters. Failure to account for sample designs often increases the risk of rejecting true null hypotheses (Beydoun et al., 2008). The NZHS methodology notes that to ensure that no group is under- or over-represented in estimates, survey weightings need to be applied to all respondents. The weight is the 'number of people' represented by one survey participant. Those with lower chances of selection are assigned higher weights and those with higher chances, lower weights. The NZHS methodology adds that weightings are designed 'to reflect the probabilities of selection of each respondent' and 'to make use of external population bench marks (such as the census), to correct for any discrepancies between the sample and population benchmarks in order to give accurate estimates and reduce bias due to non-response'. As an example, young males who have lower response rates are usually assigned a higher weight (Ministry of Health, 2008 p 33).

Each of the alcohol accessibility variables was added in each model, while controlling for potential confounding factors (Table 4.15). The models produced included seven stages;

(i) baseline model
(ii) age and gender model
(iii) ethnicity model
(iv) individual SES model
(v) individual deprivation model
(vi) urban-rural model
(vii) NZ area deprivation model

The survey design was taken into account to ensure accurate representation for all the models.

Table 4.15: Models for examining the relationship between access to alcohol outlets and alcohol-related behaviour

Baseline Model	Model 1 Age and Gender	Model 2 Ethnicity	Model 3 Individual SES	Model 4 Individual deprivation	Model 5 Urban/rural	Model 6 Area deprivation
Survey Design settings	Survey Design settings	Survey Design settings	Survey Design settings	Survey Design settings	Survey Design settings	Survey Design settings
Dependent variable - alcohol consumption/ behaviour	Dependent variable - alcohol consumption/ behaviour	Dependent variable - alcohol consumption/ behaviour	Dependent variable - alcohol consumption/ behaviour	Dependent variable - alcohol consumption/ behaviour	Dependent variable - alcohol consumption/ behaviour	Dependent variable - alcohol consumption/ behaviour
Exposure variable - access to and density of alcohol outlets	Exposure variable – access to and density of alcohol outlets	Exposure variable – access to and density of alcohol outlets	Exposure variable - access to and density of alcohol outlets	Exposure variable – access to and density of alcohol outlets	Exposure variable – access to and density of alcohol outlets	Exposure variable – access to and density of alcohol outlets
	Age and gender	Age and gender	Age and gender	Age and gender	Age and gender	Age and gender
		Ethnicity	Ethnicity	Ethnicity	Ethnicity	Ethnicity
			Personal income	Personal income	Personal income	Personal income
				Individual deprivation	Individual deprivation	Individual deprivation
					Urban/ Rural	Urban/ Rural
						Area deprivation

Table 4.15 shows that at baseline, univariate associations between neighbourhood variables and alcohol-related behaviour were tested. The baseline model included dependent (consumption) and independent variables (access/density) with no controls. In model 1, gender and age were added as control variables and changes in the relationship between neighbourhood variables and alcohol-related behaviour were monitored. This was to examine whether the relationship between the outcome and exposure variables was modified by age and gender. Model 2 was adjusted for ethnicity. The third and fourth models were adjusted for two socio-economic measures; personal income and individual deprivation. Model 5 was adjusted for urban-rural location and finally model 6 was adjusted for area deprivation. Table 4.15 shows a typical model; however, depending on the sub-population being examined, the structure might change.

For each of the independent variables, the full model was run for each of the access variables, so in total there were over 100 models.

4.3.4 Density of alcohol outlets and hospitalisation

The fifth objective *is to determine whether the density of liquor outlets has an independent effect on alcohol-related hospitalisations after controlling for potential confounding factors.*

In establishing whether or not this is the case three sub-questions were examined;

- Is there an association between alcohol-related hospitalisation and the density of alcohol?
- Is this association characteristic of different types of alcohol outlets?
- Is there an association between hospitalisation and density of different categories of alcohol outlets?

Using standardised rates of hospitalisation as the dependent variable, ordinary least squares (OLS) regression was undertaken to establish the relationship between hospitalisation and density of alcohol outlets. In New Zealand, the lowest geographical unit, meshblocks, has been used in many health studies. Since hospitalisations were only coded by CAU, analyses were undertaken at that geographic level. Similarly, densities of alcohol outlets were considered at CAU level, because access measures at broader geographical levels were considered unreliable. Confounding variables and how they were chosen are discussed in section 4.3.4.1 below followed by a discussion of the analysis steps and the reasons why OLS was chosen.

4.3.4.1 Confounding variables

There are suggestions that alcohol consumption occurs as a result of both ‘people’ and ‘place’ characteristics, therefore, researchers have been focussed on factors that enhance or reduce consumption (Pollack et al., 2005; Huckle et al., 2008). Some of these factors include individual and area level characteristics and have been discussed previously in Chapter 2 and 3. In order to examine whether alcohol outlets have an independent effect on hospitalisation, or whether some covariates confound the relationship, a range of variables was selected for inclusion in the models based on the literature reviewed in Chapters 2 and 3. A potential confounding variable is the proportion of male population within each CAU. Since it is commonly assumed that it is the older age groups who are more likely to be admitted to hospital, the proportion of those aged 65 and over was adjusted for. Other high rates of admission are found in the younger age groups and among Māori, therefore the analysis was controlled for the percentage of population aged 15-24 and the percentage of Māori in the population. Other studies have suggested that it would be important to control for the percentage of single parent households (Gruenewald et al., 2006), and urban-rural location (Jiang et al., 2008). At the CAU level, the inclusion of socio-economic and demographic variables is crucial in modelling geographic data and two measures were included, area level deprivation and median income. All these variables were available from the New Zealand 2006 census.

4.3.4.2 Analysis steps

The analysis was undertaken in four steps. First, the rates of hospitalisation and the number of outlets per CAU were established. Secondly, descriptive analysis was undertaken. Thirdly, correlation and collinearity analysis was done. The next and last step was regression analysis with selected variables.

Initially, the number of alcohol outlets within the CAU was counted. Since rates of hospitalisation differ by exposure to different types (on- and off-licences) and categories (e.g. supermarkets, bottle stores), rates for both were estimated separately at the CAU level. The number of outlets per 10 000 population was calculated by dividing the number of outlets by the total population of the CAU and multiplying by 10 000. Standardised hospitalisation rates were also calculated at CAU level and used similar method for TAs explained in section 4.3.1.2

For this analysis, OLS regression was used. This is important in modelling and the prediction of relationships of an ecological nature. OLS was chosen for this analysis because it is a reliable regression method and has a well developed theory behind it (Hamilton, 1992, Wooldridge, 2003) as it explains some causal or behavioural processes. Additionally, the OLS estimator is suggested to be a good approach as it has a smaller variance when compared to other unbiased estimators. However, with outliers, this might not be the case. Therefore all outliers were removed from analysis.

For this study, only alcohol outlets were geocoded at their specific geographic locations. OLS was therefore the most appropriate method. The dependent variable was the standardised rate of hospitalisations for each CAU. All confounder variables were entered as a block after which access variables were added and the change in R^2 monitored. To understand the relationship between the independent and dependent variables, the values of the regression coefficients were examined.

Many studies that use OLS sometimes use stepwise regression, which only maintains certain variables and sometimes omits the main explanatory variable. There are suggestions, however, that improved analysis can be undertaken by hierarchical or sequential OLS regression, where all the independent (or control) variables are entered as block and then one main independent variable is entered in the next level. According to Spicer (2005), this sequential analysis illustrates how the R^2 changes from step to step. This analysis is important since the effect of some independent variables or control variables may differ in their relationship to dependent variables and a second independent variable. Spicer (2005 p 118) adds that 'the effect of an independent variable on the dependent variable differs according to the level of the second variable'. Other studies have used this method effectively and have shown that independent variables used at different steps offered better explanations when the variables were added in a sequence (Emmons and McCullough, 2003, Kehr, 2003). For the analysis in this study, all control variables were entered as a block, after collinearity tests. The R^2 was monitored at each step, before and after adding the density of alcohol outlets as a second independent variable, to effectively examine how 'place' variables (measured by the density of alcohol outlets) contribute to increases hospitalisations or crime.

It is important to also mention residuals and collinearity. The residual is the unexplained portion of the dependent variable and is the difference between the observed and the predicted values in regression. A large residual illustrates a poor model fit and most statistical packages report residuals with every regression estimated. Regression models are not easy to specify and more often than not, cases are wrongly specified indicating that important explanatory variables are missing from the analysis. In addition, multi-collinearity occurs when one or a combination of explanatory variables is redundant. This can lead to bias and an unstable or unreliable model (Wooldridge, 2003, Hamilton, 1992). Multi-collinearity can be identified by examining the variables in correlation or undertaking collinearity tests in most statistical packages and omitting those that are strongly correlated as predictor variables (Fox, 2008).

After choosing the appropriate method, the second step was to examine the descriptive statistics of both dependent and independent variables, at the national scale and for urban and rural areas (Tables 4.16–4.18). These tables show the total number of CAU in both urban and rural areas, excluding CAUs with no population. These tables illustrate the minimum and maximum number of standardised hospitalisations per CAU. The standard deviations show that the variables are dispersed, far from the mean. Most of the variables were right skewed with a few outliers, showing that the data did not have normal 'bell' curve distribution. However, since the variables were not a sample, the data was not transformed. Field (2009) also suggested that raw data rarely need to be normally distributed.

Table 4.16: Descriptive statistics for all the variables to be used in regression

Dependent variable	**Number**	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Age-standardised hospitalisation rate	1 649	0	5 255.7	201.2	226.8
Independent Variables					
Alcohol outlets density/access					
Rates of outlets per 10 000	1 649	0	1 303.9	24.8	73.9
Rates of on-licenses per 10 000	1 649	0	909.1	12.7	46.0
Rates of off-licenses per	1 649	0	505.1	12.9	33.4
Rates of hotel/pub/tavern licenses per 10 000	1 649	0	1 232.8	19.2	62.4
Rates of supermarkets/ general stores/dairies per 10 000	1 649	0	156.1	3.5	9.1
Rates of Bottle stores per 10 000	1 649	0	222.2	2.9	11.6
Confounders					
NZ Deprivation	1 640	1	5	2.8	1.4
Single parent headed households	1 649	0	56.4	16.8	8.7
Median income (in NZ$)	1 649	18 200.0	100 000.0	52 134.0	16 890.0
Percentage 15-24	1 649	3.0	88.1	14.3	6.4
Percentage 55-64 years	1 649	0	27.2	8.4	2.4
Percentage 65 years and above	1 649	0	43.4	11.1	5.8
Percentage Māori ethnicity	1 553	0	91.8	18.2	14.7
Percentage males adult 15+	1 649	35.0	83.54	48.9	3.5

Analyses for urban and rural areas revealed two outliers in urban areas which were consequently excluded from the final analysis. Rural areas have lower hospitalisation rates than urban areas.

Table 4.17: Descriptive statistics for all the variables in urban areas to be used in regression

Dependent variable	Number	Minimum	Maximum	Mean	Standard Deviation
Age-standardised hospitalisation rate	1 214	0	1 751.9	212.4	186.9
Independent Variables					
Alcohol outlets density/access					
Rates of outlets per 10 000	1 214	0	1 303.9	20.3	72.7
Rates of on-licenses per 10 000	1 214	0	909.0	10.3	43.7
Rates of off-licenses per 10 000	1 214	0	505.0	10.1	31.0
Rates of hotel/pub/tavern licences per 10 000	1 214	0	1 065.1	14.3	55.4
Rates of supermarkets/general stores/dairies per 10 000	1 214	0	156.1	2.7	7.9
Rates of Bottle stores per 10 000	1 214	0	222.2	3.4	12.3
Confounders					
NZ Deprivation	1 210	1	5	2.8	1.4
Single parent headed households	1 214	0	56.4	18.0	8.6
Median income (in NZ$)	1 214	20 600.0	100 000.0	53 605.1	17 732.1
Percentage 15-24	1 214	3.0	88.1	14.3	6.4
Percentage 55-64 years	1 214	0	27.2	8.1	2.3
Percentage 65 years and above	1 214	0	43.4	11.8	5.8
Percentage Māori ethnicity	1 214	0	83.1	17.2	13.0
Percentage males adult 15+	1 214	35.0	76.9	47.9	2.8

Table 4.18: Descriptive statistics for all the variables in rural areas to be used in regression

Dependent variable	Number	Minimum	Maximum	Mean	Standard Deviation
Age-standardised hospitalisation rate	433	0	1 397.9	152.6	152.1
independent Variables					
Alcohol outlets density/access					
Rates of outlets per 10 000	433	0	459.8	33.8	51.6
Rates of on-licenses per 10 000	433	0	229.9	16.7	28.5
Rates of off-licenses per 10 000	433	0	229.9	19.1	28.3
Rates of hotel/pub/tavern licenses per 10 000	433	0	459.8	29.4	49.6
Rates of supermarkets/general stores/dairies per 10 000	433	0	66.7	5.4	11.3
Rates of Bottle stores per 10 000	433	0	28.2	0.9	3.7
Confounders					
NZ Deprivation	428	1	5.0	2.8	1.3
Single parent headed households	433	0	47.8	13.2	7.9
Median income (in NZ$)	433	18 200	100 000.0	48 041.8	13 491.9
Percentage 15-24	433	0	39.3	10.6	3.5
Percentage 55-64 years	433	0	20.4	9.1	2.8
Percentage 65 years and above	433	0	37.2	9.0	5.1
Percentage Māori ethnicity	433	0	91.8	21.3	18.3
Percentage males adult 15+	433	36.3	83.5	51.7	3.9

The third step was to determine by correlation whether there is a relationship between different measures of the density of alcohol outlets and age-specific hospitalisation rates. This established whether further testing was warranted in regression, since correlation precedes regression (Wooldridge, 2003, Hamilton, 1992) because strong correlations between explanatory and dependent variables point to a positive result in regression. Correlation was also undertaken to investigate the relationship, on one hand, between both the control and explanatory variables, and on the other hand amongst control variables. Strong correlation amongst control variables is a precursor to multi-collinearity. Whilst correlation is important in showing which variables influence each other, it does not explain which of the variables contributes to the proportion of variance in more than one variable, and therefore, further collinearity tests were undertaken in SPSS during analysis with such identified variables removed from the analysis. In short, multi-collinearity occurs when independent variables are correlated and therefore the regression coefficients produced are unreliable (Fox, 2008).

The fourth and last step involved, OLS regression analysis, was to examine the relationship between hospitalisations and the covariates. As stated earlier, all the confounding variables were entered as a block and the density of alcohol outlets entered in the next step. The dependent variable was age specific rates for hospitalisation and the predictor variable density of different types and categories of alcohol outlets.

An example of a model is specified in Table 4.19 and approximately 24 models were run to show increase in R^2 value when the access measures were added. For this analysis, the dependent variable was standardised rates of hospitalisation at CAU level. All the control variables were entered as a block in the regression. Each of the alcohol density variables were then entered independently in the next step and changes in R^2 observed.

Table 4.19: Typical model used in ordinary least squares regression

Regression models for census area units – age-standardised hospitalisation rates per 100 000	
Baseline model	**Model 1**
1. One parent headed household 2. NZ deprivation 3. Percentage of population aged 65+ 4. Percentage 15-24 years 5. Percentage Māori	1. Alcohol outlets per 10 000 population
Change in R^2 relative to baseline model	

4.3.5 Density of alcohol outlets and crime

The sixth and final objective *is to determine whether the density of alcohol outlets has an effect on crime after controlling for potential confounding factors.*

In determining whether or not this effect occurs, three sub-questions were examined:

- Is there an association between crime and alcohol outlet density for all alcohol outlets per 10 000 in TLAs?
- Is there an association between crime and alcohol outlet density for different types of alcohol outlets?
- Is there an association between crime and alcohol outlet density for different categories of alcohol outlets?

Crime data is discussed, as are the reasons for conducting the analysis on a larger geographical scale and the different analysis steps are described.

While the research was more interested in ‘place’, sometimes the type of analysis undertaken was determined by the data available. As an example, crime data was only available for police station districts and not for CAUs or meshblocks. This data was provided in Excel spreadsheets and could only be aggregated to TA level; therefore any analysis in either larger or smaller units was not possible, except at TA level. Data pre-test analysis at police district level showed unusually high correlation and strong regression variances since some areas, such as New Plymouth, had more crimes than it had people.

Other studies have indicated that the population living around, or who frequent, alcohol outlets are an important determinant of the type of crime occurring. While the data obtained for this study was just for general crime, better data would have also outlined the socio-demographics of the victims allowing for analysis by different sub-populations. Despite these limitations, many overseas studies (Scribner et al., 2000, Roman et al., 2008) have used density measures to examine the relationship between crime and alcohol outlets at a national level, but such studies are rare in New Zealand. The Ministry of Justice reports that the evidence linking crime to alcohol in New Zealand is largely anecdotal, yet in Wellington alone, alcohol is reported to be responsible for 66% of the arrests and 90% of the offences committed on Fridays and Saturdays (Wood, 2005). This study will therefore examine the relationship between density of alcohol outlets and crime.

It should be noted that ecological studies may not adequately explain the link between crime and alcohol outlets (Gruenewald et al., 2006). The limitations notwithstanding, (of ecological) recent research in Manukau has shown that a higher density of off- and on-licenced premises has a strong and positive relationship with crime (Cameron et al., 2010).

For this analysis, the density of alcohol outlets was calculated at TA level. OLS regression analysis was undertaken, similar to the previous analyses estimating the relationship between crime and the density of alcohol outlets. Descriptive statistics are presented to highlight the distribution of the density and control variables at the TA level. Correlation was undertaken for all the variables in order to test for multi-collinearity. This analysis was stratified by violent minor and serious violent crime.

4.3.5.1 Confounding variables

Similar to the relationship between outlets and hospitalisation, many studies have been concerned that alcohol consumption is both as a result of people and 'place' characteristics (Ellaway et al., 2010, Huckle et al., 2008; Macintyre et al., 2002). Since outlets are used as a proxy, studies have suggested that there is a need to control for certain individual and place characteristics. Gruenewald et al., (2006) have listed a number of variables that should be controlled for, these include:

(i) deprivation index scores (poverty)

(ii) percentage of Māori in the population

(iii) the adult population

(iv) percentage of males in the population

(v) percent of those aged 15-24 years

(vi) unemployment rates in each TLA.

All these variables were extracted from the 2006 census.

4.3.5.2 Analysis steps

The analysis was conducted in five steps. The first was to count the number of crimes committed within each TA, divide those by the total population of the relevant TA and then multiply by 10 000 to yield the rate of crime per 10 000 population as per the following equation.

$$\frac{total\ number\ of\ crime\ in\ TA}{total\ population\ in\ TA} \times 10\ 000$$

The total population here refers to adults 15 years and over, used in international research (Gruenewald et al., 2006).

The second step was to calculate the density of alcohol outlets at the TA level. As with hospitalisation, the density of outlets per 10 000 population was calculated at TA level. Descriptive analysis was then undertaken in the third step for all variables used in regression.

Table 4.20: Descriptive analysis for minor violent crime

	Number	Minimum	Maximum	Mean	Standard Deviation
Dependent variable-place where minor crime occurred					
Dwelling	72	3.3	96.5	39.8	18.8
Licensed Premises	72	0.5	24.4	4.1	3.3
Public Places /Roads	72	1.5	40.9	22.1	8.7
Other	72	0	45.2	4.5	5.7
Total	72	5.6	129.3	70.5	27.3
Explanatory variables					
Rates of outlets per 10 000	72	3.3	92.9	28.5	18.8
Rates of off-licenses per 10 000	72	1.9	50.1	14.8	9.8
Rates of on-licenses per 10 000	72	1.4	42.7	13.6	9.6
Rates of hotels/pubs/taverns licenses per 10000	72	0	11.3	2.8	1.8
Rates of supermarkets/ general stores/dairies per 10000	72	1.9	73.7	21.1	16.0
Rates of Bottle stores per 10 000	72	0	14.7	4.4	3.0
Control variables					
Unemployment rates	72	1.0	7.6	3.0	1.1
Percentage 15-24	72	10.4	25.9	15.8	3.0
Percentage Māori	72	4.3	58.5	17.5	12.4
Percentage Males	72	46.5	53.4	49.4	1.1
Percentage adults	72	71.8	83.6	77.9	2.6
Area deprivation	72	1.0	5.0	3.0	1.4

Descriptive statistics show the minimum, maximum, mean and standard deviation of all the variables used in regression analysis. Tables 4.20 and 4.21 show the descriptive statistics of crime rates per 10 000 population in 72 of New Zealand’s 74 TAs, where data were available for both alcohol outlets and crime. In addition, descriptive statistics for rates of outlets as well as control variables are illustrated. Two TAs, including the Chatham Islands, are not included because of missing data. The mean for most variables was higher than zero, with large standard deviations indicating that the data were not normally distributed. Kurtosis and skew analysis (not shown) show that the data is right skewed, especially for minor violent crime and density of alcohol outlets. The variables were not log transformed because they are not a sample; instead they represent the total number of crimes that occurred (Field 2009). Most census variables were normally distributed as can be observed by the low standard deviations.

Table 4.21: Descriptive analysis for serious violent crime

	Number	Minimum	Maximum	Mean	Standard Deviation
Dependent variable - place where serious minor crime occurred:					
Dwelling	72	7.84	76.96	34.45	13.67
Licensed Premises	72	0.89	39.91	4.63	4.97
Public place/Roads	72	5.27	64.57	30.17	10.70
Other	72	0.39	28.20	5.06	3.70
Total	72	15.43	145.81	74.31	24.03

The descriptive analysis (Table 4.21) shows that both the density of serious violent crime and alcohol outlets have means that are much higher than zero, and the standard deviations are also large showing that the data is not normally distributed. Some of the data is right skewed (kurtosis and skew analysis, not shown). Since the independent variables are same for both minor and violent crime, the descriptive statistics are not repeated.

The fourth step was to test the confounding and explanatory variables for collinearity and collinear variables were removed. The fifth and final step involved OLS regression analysis to examine the relationship between crime and the covariates. For this analysis the independent variable was rates of crime per 10 000 population. The explanatory variables were measures of density of alcohol outlets, while adjusting for a range of confounding variables.

Given that police districts do not completely fit within particular TAs, proportions of crime were assigned to TAs based on the size of the police district within the TA. For example if a police district had within its boundary 60 % of TA ‘one’ and 40 % of TA ‘two’, crime rates were then assigned to the TA based on those proportions. Thirty TAs had crime rates assigned this way ranging from 13% for the smallest proportion to 86% for the largest. Tests were undertaken in regression where all the TAs with assigned proportions were removed from the analysis and then compared to an analysis with all the TAs included. The information in Table 4.23 shows that there is no difference between including all of the TAs and excluding those TAs with assigned proportions, thus validating the proportion assignment. The differences are very minimal and cause no concern for bias in the results.

Table 4.22: Regression results crime occurring at licensed premises and density of on-licences and off- licences, controlling for confounding variables by comparing TAs with and without assigned proportions of crime.

	Serious violent crime occurring at licensed premises - all TAs included (n = 72)				**Serious violent crime occurring at licensed premises - all TAs with proportions removed (n = 44)**			
Variables	**Standardized Coefficients**	**p-value**	**R^2**	**Net R^2 due to density variable**	**Standardized Coefficients**	**p-value**	**R^2**	**Net R^2 due to density variable**
				On-licences				
(Constant)		0.940				0.933		
% 15-24	0.070	0.560			0.043	0.779		
% Māori pop	0.497	0.003			0.630	0.007		
NZ deprivation	-0.299	0.075	0.056		-0.331	0.146	0.067	
On-licenses	**0.385**	**0.002**	**0.181**	**0.125**	**0.398**	**0.012**	**0.189**	**0.121**
				Off-licences				
(Constant)		0.875				0.687		
% 15-24	0.104	0.428			0.112	0.521		
% Māori pop	0.469	0.006			0.601	0.011		
NZ deprivation	-0.319	0.063	0.056		-0.343	0.141	0.067	
Off-licenses	**0.344**	**0.008**	**0.138**	**0.082**	**0.390**	**0.026**	**0.162**	**0.095**

Chapter 5 Geography of alcohol consumption

5.1 Introduction

Much of the literature on the determinants of health, including alcohol consumption, has focussed on differences in individual socio-economic status as a primary risk factor (Blomgren et al., 2004, Casswell et al., 2003, Droomers et al., 2003, Rice et al., 1998). It has been shown that variations in health between places can be attributed to both the characteristics of the people who live in those places (composition) and also to the places where people live (context). In recent times there has been considerable interest in the role of neighbourhoods, specifically, whether their social and physical characteristics are important in explaining inequalities in health. In New Zealand, alcohol consumption is suggested to contribute to an increase in inequality.

Chapter 4 examined the data sets and methods used in the analysis. This chapter examines descriptive trends in the proxies of alcohol consumption to determine how both compositional and contextual factors have an association with mortality and hospitalisation. This is important because recently, research has shown that there has been an increase in alcohol-related hospitalisations and mortality (Scottish Government Statistics, 2009). This trend is associated with an increase in hazardous alcohol consumption internationally with most surveys reporting an increase (AIHW 2005, Health Canada 2005, Plant and Plant 2006). New Zealand is no exception to this trend. There is a social gradient showing that those living in areas of high social deprivation are more likely to be hazardous consumers of alcohol (NZHS 2006/07).

Studies, both local and international, that examined alcohol-related hospitalisation reported that minor diseases, such as alcohol poisoning, are prevalent amongst younger age groups (Christie, 2008) while older age groups are more likely to be admitted for serious conditions such as liver cirrhosis and pancreatitis. Recent research has shown that pancreatitis is on the increase among the younger age groups and for women, who traditionally were moderate consumers of alcohol (O'Farrell et al., 2007, Sand et al., 2009, Tinto et al., 2002). In New Zealand, there is a dearth of studies that examine alcohol hospitalisation especially the ICD codes that are associated with alcohol (i.e. excluding car accidents and other cases attributed to alcohol but not directly caused by alcohol).

The purpose of this study is to examine alcohol-related hospitalisations and mortality as a proxy for consumption and to determine how trends in consumption in New Zealand compare to trends elsewhere. This chapter has two objectives. The first is to establish the geography of alcohol consumption for small areas in New Zealand. The second is to determine the spatial and temporal variations of hospitalisation and mortality. Hospitalisation and mortality data is collated by the NZHIS as described in the previous section 4.2.1.1 above.

This chapter is organised as follows. Section 5.2.1 will report the trends over time for different population groups, followed by the geography of the different population groups (Section 5.2.2-5.2.5). Also examined is the extent to which the hospitalisation is predicted by area deprivation after controlling for both composition and location factors (5.2.6). Hospitalisation and mortality are discussed separately.

5.2 Descriptive alcohol-related hospitalisation trends

5.2.1 Total hospital admissions

As mentioned in Chapter 4, between 1999 and 2006 there were 80 342 recorded hospitalisations. The official data collated for hospitalisations represents all individuals irrespective of the number of times they were admitted; therefore some people are counted more than once. When such data is standardised, there is a risk of double counting. To avoid double counting in this study, all re-admissions were identified by their unique NHI numbers and excluded from the analysis, by each calendar year. Only the first admission for each person for every year was retained in the final data set. The final total for all years in this study was 60 182, excluding repeat admissions. Table 5.1 illustrates the difference between single admissions and re-admissions in each calendar year.

Table 5.1: Total alcohol-hospitalisation in New Zealand after excluding re-admissions

Year	Total admissions excluding re-admissions	Repeat admissions excluded from analysis
1999	6 867	2 395
2000	7 336	2 409
2001	7 506	2 563
2002	7 425	2 509
2003	7 433	2 580
2004	7 358	2 591
2005	7 871	2 452
2006	8 386	2 716

Table 5.2: Total alcohol-related hospitalisations in New Zealand (excluding re-admissions) by gender and year in New Zealand

Years	Gender		Total
	Female	Male	
1999	2 073 (30.2%)	4 794 (69.8%)	6 867 (100%)
2000	2 296 (31.3%)	5 040(68.7%)	7 336 (100%)
2001	2 477 (33.0%)	5 029(67.0%)	7 506 (100%)
2002	2 480 (33.4%)	4 945 (66.6%)	7 425 (100%)
2003	2 563 (34.5%)	4 870 (65.5%)	7 433 (100%)
2004	2 527 (34.3%)	4 831 (65.7%)	7 358 (100%)
2005	2 712 (34.5%)	5 159 (65.5%)	7 871 (100%)
2006	2 961(35.3%)	5 425(64.7%)	8 386 (100%)
Total	**20 089 (33.38%)**	**40 093 (66.62%)**	**60 182 (100%)**

Table 5.2 indicates that more males were hospitalised than females. Disaggregated by age groups, Table 5.3 shows all age groups, males and female combined. Most admissions were in the 15–24 and 65+ age groups. These are crude proportions and only include proportions for first alcohol-related admissions in each calendar year. Crude proportions do not represent the population well and therefore rates are age

standardised. Standardisation is important because it accounts for the differences in age structure.

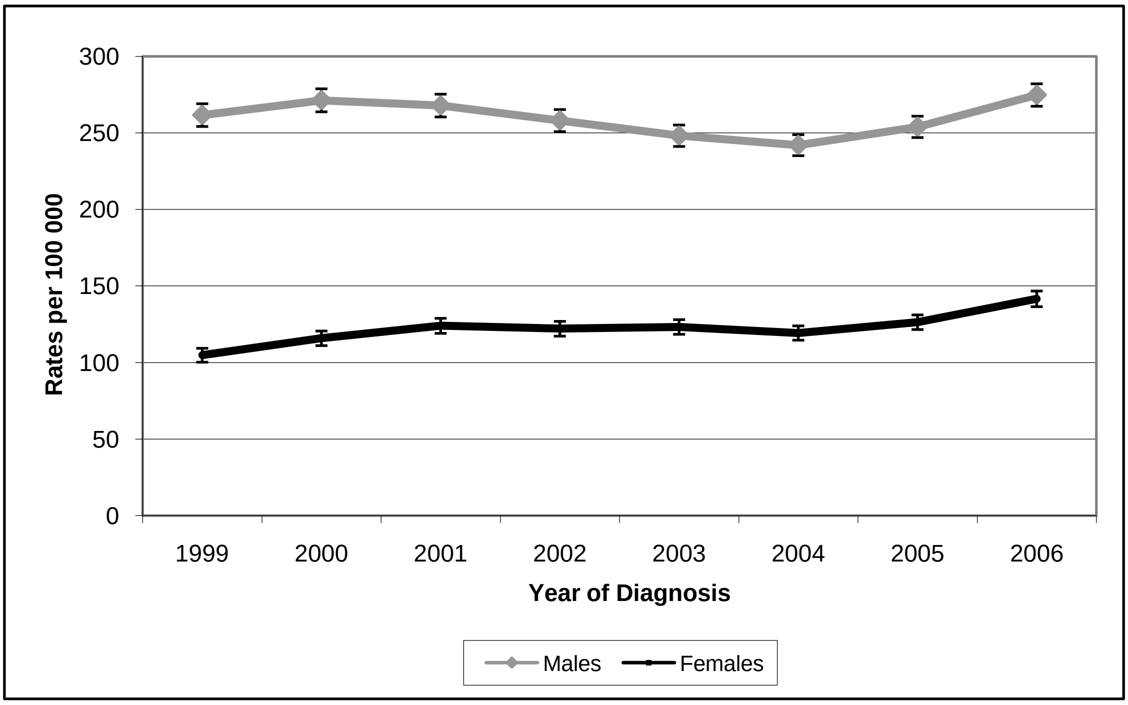
Table 5.3: Total alcohol-related hospitalisations in New Zealand by age group

Years	Age group-in years							Total
	0-14	**15–24**	**25–34**	**35–44**	**45–54**	**55–64**	**65+**	
1999	137 (2%)	1261 (18.4%)	1233 (17.9%)	1155 (16.9)	958 (13.9%)	758 (11.0%)	1365 (19.9%)	**6867 (100%)**
2000	218 (2.9%)	1551 (21.1%)	1356 (18.5%)	1278 (17.4%)	987 (13.5%)	748 (10.2%)	1198 (16.3%)	**7336 (100%)**
2001	193 (2.6%)	1700 (22.7%)	1377 (18.4%)	1280 (17.1%)	1042 (13.9%)	732 (9.8%)	1182 (15.8%)	**7506 (100%)**
2002	194 (2.6%)	1690 (22.8%)	1299 (17.5%)	1361 (18.3%)	1042 (14.0%)	741 (9.9%)	1098 (14.8%)	**7425 (100%)**
2003	150 (2.0%)	1667 (22.4%)	1319 (17.8%)	1290 (18.0%)	1085 (14.3%)	828 (10.8%)	1094 (14.7%)	**7433 (100%)**
2004	117 (1.6%)	1686 (22.9%)	1299 (17.7%)	1329 (18.0%)	1055 (14.3%)	794 (10.8%)	1078 (14.7%)	**7358 (100%)**
2005	134 (1.7%)	1928 (24.5%)	1340 (17.0%)	1453 (18.5%)	1133 (14.4%)	845 (10.7%)	1038 (13.2%)	**7871 (100%)**
2006	138 (1.7%)	2112 (25.1%)	1294 (15.4%)	1531 (18.3%)	1259 (15.0%)	898 (10.7%)	1154 (13.8%)	**8386 (100%)**

5.2.2 Hospitalisation trends by age and gender

Hospitalisation rates were age standardised with the 2001 population as the standard. Figure 5.1 indicates the age-standardised rates for males and females. Male rates are higher than female rates, however, the difference reduced significantly (from 150 in 1999 to 130 per 100 000 by 2006). In addition, the gap between males and females over the eight year period was fairly consistent with male rates being almost double the female rates. As illustrated in Figure 5.1, the age-standardised rates for males and females show an increase in female hospitalisation from 105 per 100 000 in 1999 to 142 per 100 000 in 2006. The male rates also increased from 254 in 1999 to 271 per 100 000. These gender differences are manifested in different age groups and therefore analysis was conducted for each age group and gender.

Figure 5.1: Age-standardised alcohol-related hospitalisations by gender for alcohol-related diseases in New Zealand (1999–2006)



In line with international evidence, Figure 5.2 illustrates age and gender variations in hospitalisation rates. The highest rate of growth was for the younger males aged 15–24. There was a significant decline for the oldest age group (65 and over) from 64 (CI 60.2-68.1) to 47 (CI-44.2-50.6) per 100 000. In contrast, the rates of the 25–44 year age group are fairly consistent at 30 to 50 per 100 000 with low confidence intervals. Overall, the 15–24 year age group has the highest hospitalisation rates (see Appendix 1 for confidence intervals).

Figure 5.3 illustrates that for females the temporal trends differ from those of males. All age groups record an increase in hospitalisation over the years with the exception of the oldest age group 65 years and over and the youngest age group below 14 which both declined although the 0-14 year age group decline was minimal. Females aged 25–44 follow a similar pattern to males where the rates are fairly consistent with low confidence intervals. Of particular interest is the widening gap between the age groups 15–24 and 25–44, especially between 1999 and 2004. This is because the 15–24 age group had the highest growth rates where the rates almost doubled from 20 (CI 18.7-22.8) to 38 (CI 35.5-40.8) per 100 000 within eight years (See Appendix 2 for confidence intervals).

Figure 5.2: Age-specific standardised rates of alcohol-related hospitalisations for males in New Zealand

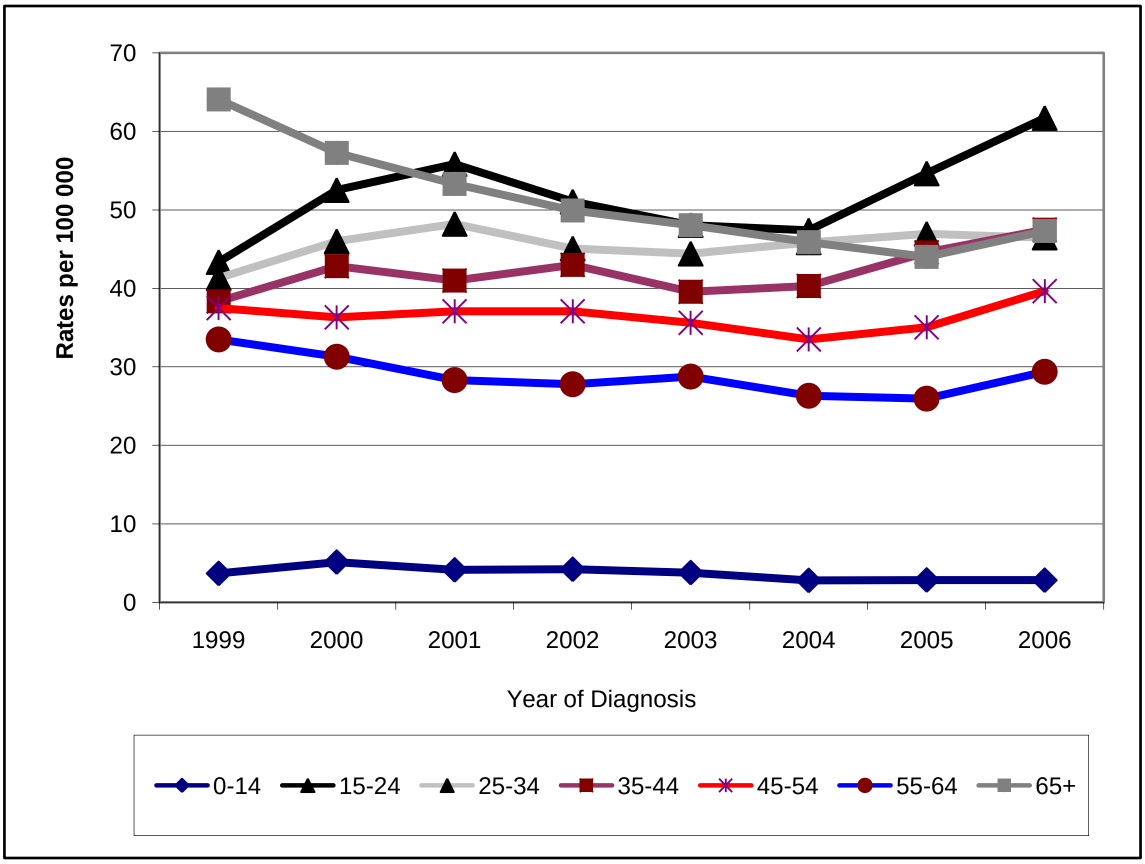
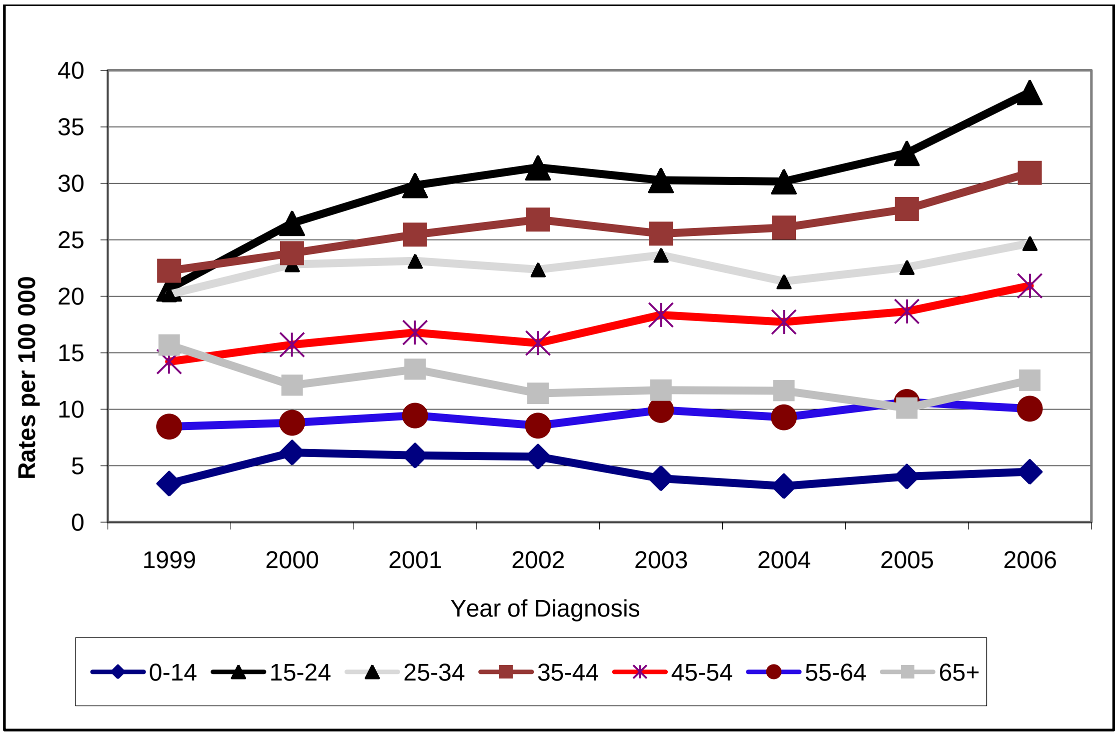


Figure 5.3: Age specific standardised rates of alcohol-related hospitalisation for females in New Zealand

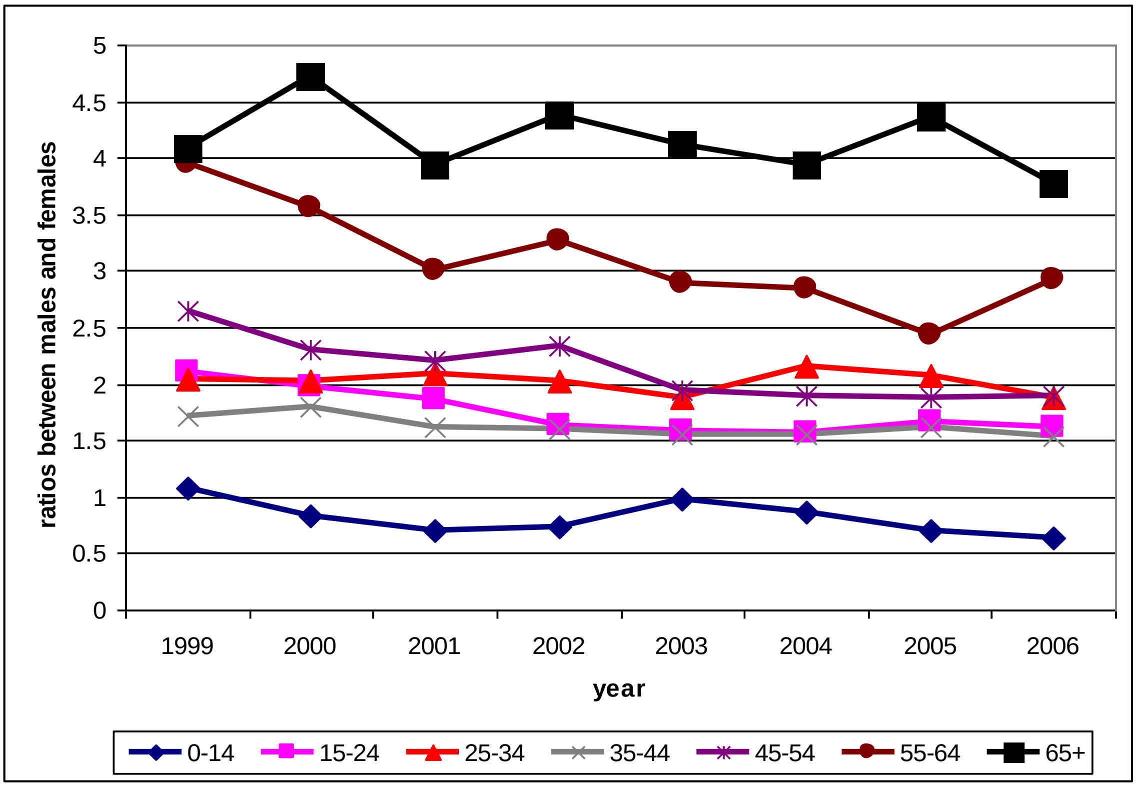


The results presented above show that hospitalisation rates have increased substantially for both males and females, with only a slight decline for males between 2002 and 2004. The confidence intervals are also small. The results generally show an inverse relationship, with admission rates falling as age increases. But the biggest increase in admission rates over time is observable for 15–24 year old males and females. Further analysis is undertaken to compare the rates between males and females by age group.

Figure 5.4 summarises the ratio difference between the overall hospitalisation rates for males and females. For all the age groups, the ratios have been gradually declining over the years, showing that more females are consuming enough alcohol to warrant hospitalisation. The difference in the ratios between males and females is much lower in the younger age groups compared to the older age group. On average there were twice as many males as females hospitalised from the age 15 to 54 and the ratio increases to an average of three and four times in the older age groups. In terms of differences between males and females, the gap in hospitalisation rates is narrowing over time. It is anticipated that if male rates continue to decrease, accompanied by continuing increases for women, the gender differences in hospitalisations will converge.

Further analysis was undertaken to examine the percentage change for both genders by age groups to explain the ratios observed in Figure 5.4. It is surprising that the biggest increase (84%) in hospitalisation over the years was in younger females aged 15–24 (Appendix 3). There is overall a significant increase in almost all the female age groups, except for a decline in the 65 and above age group. This difference highlights the reasons for temporal trends observed in Figure 5.1. While most male age groups recorded an increase but not as high as females, there was a decline for males aged 55 years and above. Surprisingly, for those aged 15–24, the increase in rates for males and females was 42% and 84% respectively over the years.

Figure 5.4: Ratio between male and female alcohol-related hospitalisation rates by age groups in New Zealand



5.2.3 Hospitalisation trends by ethnicity

There is evidence that consumption patterns vary significantly between different ethnic groups. Ethnic groups vary from country to country and there are marked differences within America as well as within Europe and Asia. The research results are not always consistent across different countries (WHO 2004). In New Zealand, there are suggestions that different ethnic groups have different consumption patterns (NZHS 2006/2007). To understand the consumption patterns in ethnic groups, the descriptive results presented here are for Māori and non-Māori.

There are differences in age and gender hospitalisation rates for both Māori and non-Māori ethnic groups (Table 5.4). Māori hospitalisation rates are higher than all the other ethnicities combined with the rates almost twice the average when compared to non-Māori. Māori male rates are almost one and a half times higher than non-Māori, while the female rates are almost double those of non-Māori. The temporal trends illustrate that the gap between the two ethnic groups has remained almost the same

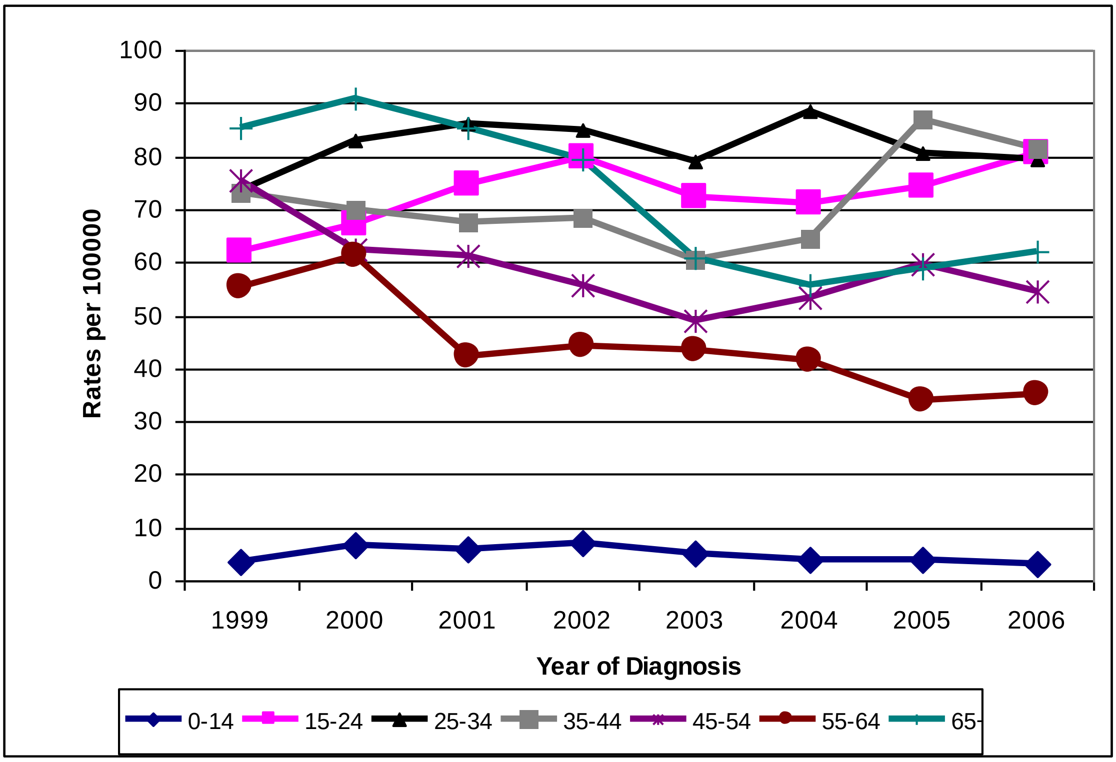
Table 5.4: Age-standardised ethnic rates for Māori and non-Māori in New Zealand

	1999	2000	2001	2002	2003	2004	2005	2006	Total
Non- Māori Male	***231.6***	***240.3***	***236.8***	***225.5***	***222.8***	***214.3***	***226.1***	***247.9***	***230.7***
LCI	224.3	232.8	229.4	218.3	215.8	207.5	219.2	240.5	
UCI	239.1	247.9	244.4	232.8	229.9	221.3	233.2	255.4	
Non-Māori Female	**84.3**	**91.1**	**101.3**	**99.7**	**101.2**	**98.5**	**103.9**	**116.9**	**99.6**
LCI	80.2	86.8	96.8	95.2	96.8	94.1	99.5	112.1	
UCI	88.6	95.5	106.0	104.3	105.8	103.0	108.5	121.8	
Māori male	***428.3***	***441.3***	***423.1***	***419.6***	***370.8***	***379.1***	***398.5***	***396.7***	***407.2***
LCI	400.7	413.8	397.0	394.0	347.2	355.5	374.5	373.0	
UCI	457.3	470.1	450.5	446.3	395.6	403.8	423.7	421.6	
Māori Female	**176.9**	**199.1**	**193.9**	**193.7**	**198.4**	**179.1**	**198.3**	**216.9**	**194.5**
LCI	161.0	182.8	177.9	177.8	182.4	164.2	182.7	200.9	
UCI	194.0	216.4	210.9	210.6	215.3	194.9	214.9	233.9	

over the seven year period, while Māori male hospitalisation rates have declined since 2003. Māori female rates have increased every year except for a decline in 2004.

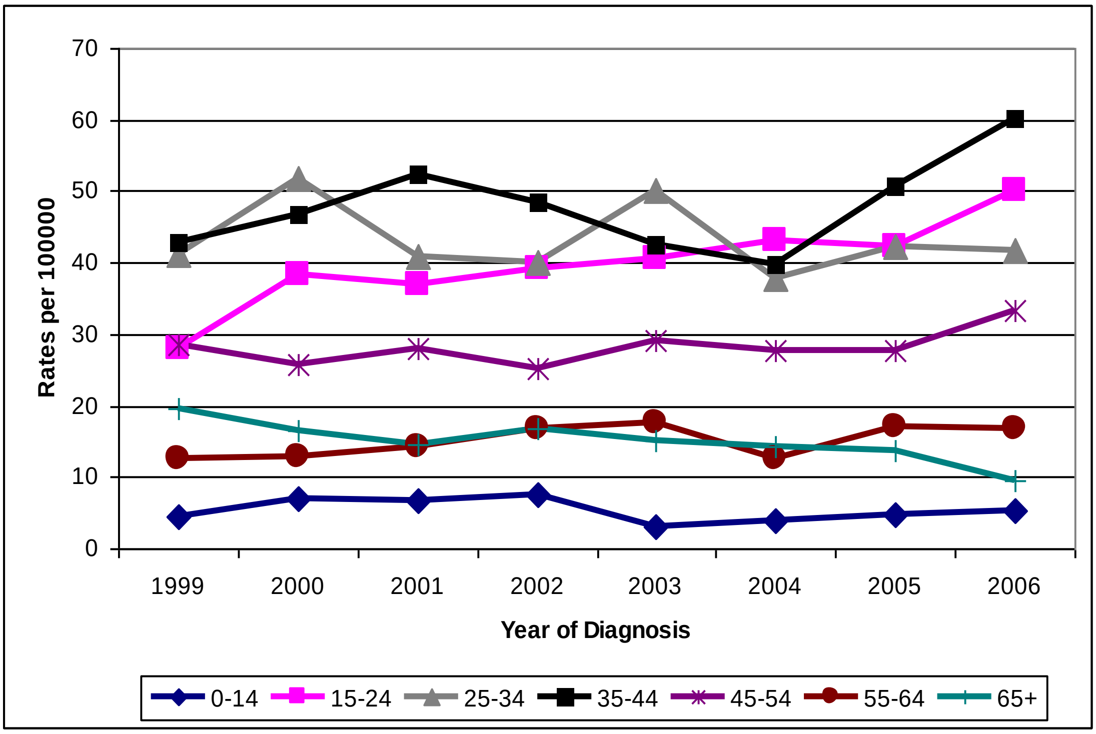
To better understand why Māori rates are higher than non-Māori, further analysis was undertaken for Māori by age group. Figures 5.5 and 5.6 indicate that the Māori rates show a different trend from those of the total population reported in Figures 5.2 and 5.3. Whereas for males in the general population, the 15–24 age group had the highest rates for most of the years with a slight decline towards 2004, for Māori males the highest rates were in the 25–34 age group, although by 2006 they had been surpassed by the younger 15-24 age group. Māori rates have been declining over the years for all the age groups except for the 15–24 age group, who had the fastest growing hospitalisation rate from 2004 onwards 71.2 (CI 63.3,-79.0) to 80.7 (CI 72.3-89.7). The confidence intervals for the male rates from 25 years upward were slightly high, indicating that the rates were not stable and the increases or decreases could be by chance (see Appendix 4 for details).

Figure 5.5: Temporal trends for age standardised alcohol-related hospitalisation rates for Māori males in New Zealand



For females in the general population trend showed high rates for those aged 15–24, while for Māori females, the 35–44 age group which, despite a fluctuation in 2004, had the highest growth rates (Figure 5.6). The highest hospitalisation rates were in the 15–44 age groups, while the rates of those above 45 were fairly stable. The confidence intervals for the 35-44 years were fairly low. For example, from 2004 the standardised rate was 39.8 (CI 32.7-47.9) and increased to 60.3 (51.6-70.3) in 2006. However, it is worth noting that there was an overlap of confidence intervals with other age groups who recorded an increase, such as 15-34 year olds (see Appendix 5 for details).

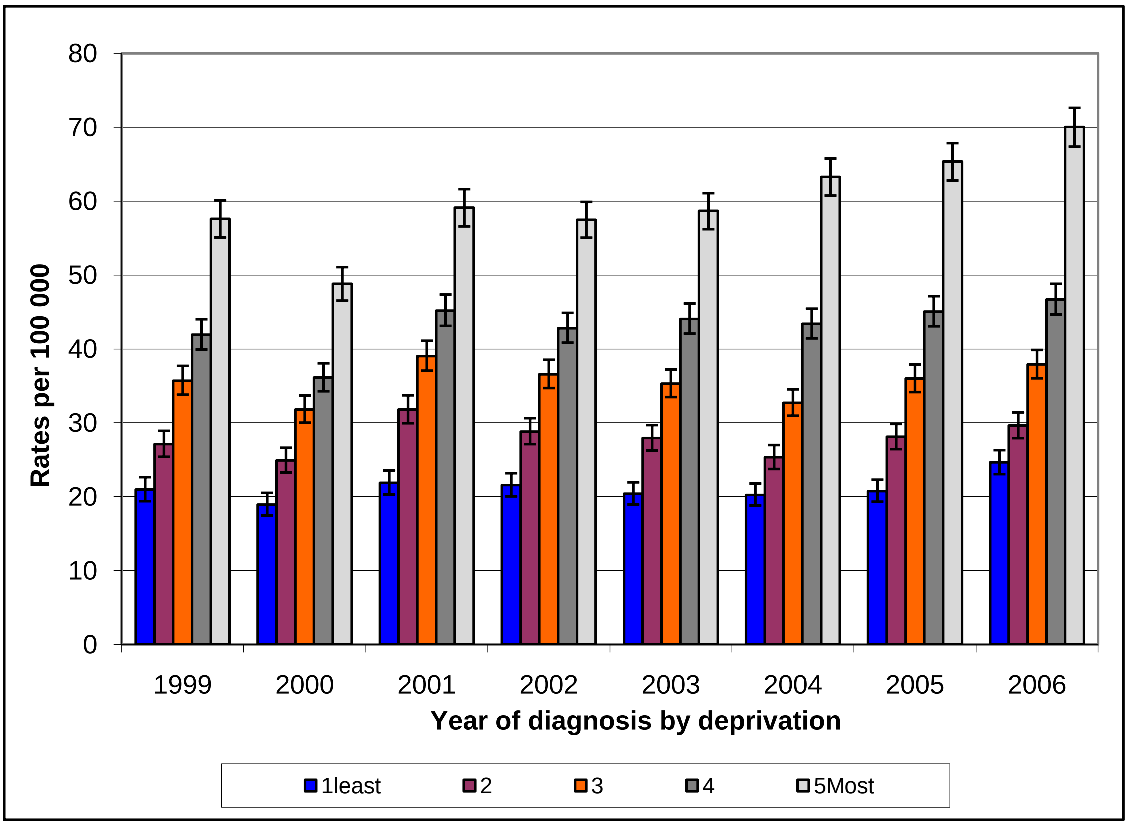
Figure 5.6: Temporal trends for age standardised hospitalisation rates for Māori females in New Zealand



5.2.4 Hospitalisation trends by deprivation

Figure 5.7 indicates age-standardised hospitalisation rates by deprivation with the results reported by quintiles. For all years there is a social gradient in alcohol hospitalisation with the least deprived quintile having the lowest rates compared to the most deprived. The rates in the most deprived quintile have been growing at a much higher rate than those in the least deprived quintiles. The most deprived rates increased significantly by almost 12 per 100 000 (from 58–70 per 100 000) compared to about 4 (from 20–24 per 100 000) for the least deprived, almost a three-fold difference, from 1999–2006.

Figure 5.7: Hospital related admission by deprivation and year in New Zealand



A similar social gradient was observed in rates for both males and females (Figure 5.8). While the gradient remained for all the years with both males and females having higher rates in the most deprived quintiles compared to the least deprived, the social gradient in hospitalisation rates was much stronger for males than females. For example, in 1999 while there is a two-fold difference between the females in most and least deprived quintiles, the male difference is three-fold. The male rates were more stable than female rates that had confidence intervals overlapping in between the quintiles.

Figure 5.8: Hospital related admission by deprivation, gender and year in New Zealand

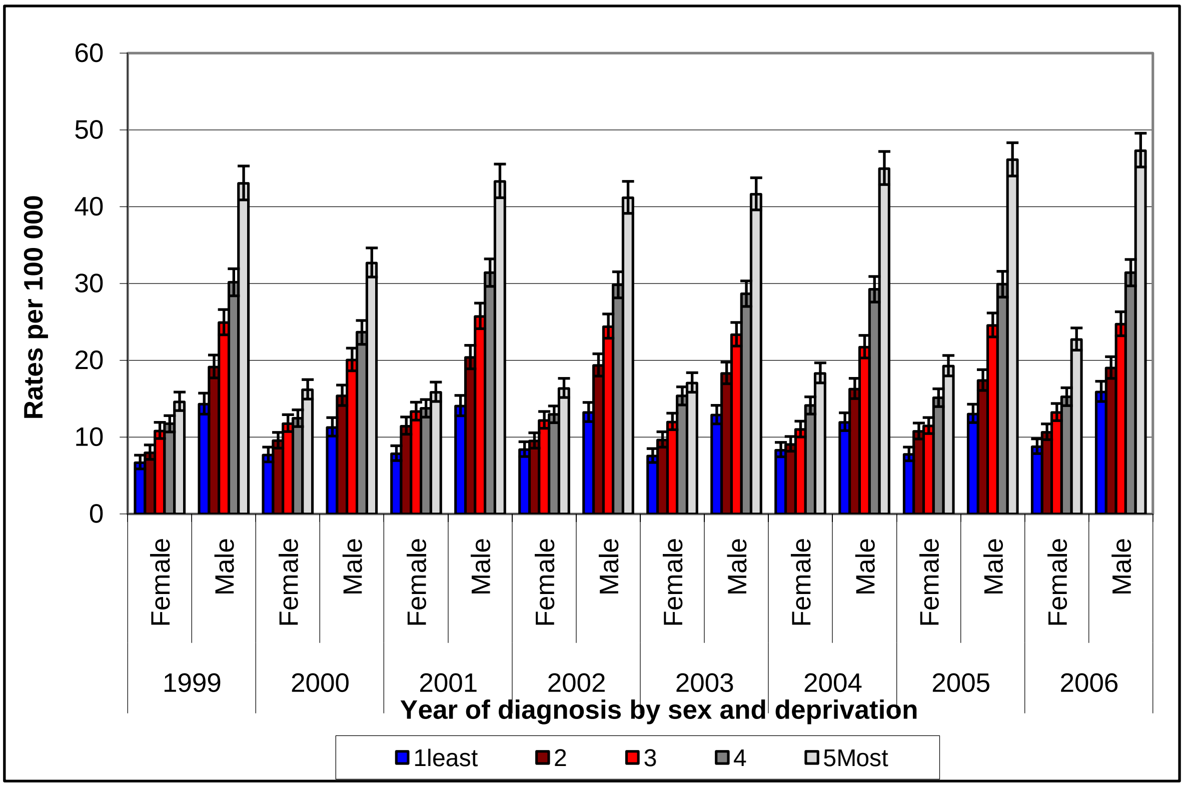


Table 5.5: Ratio of hospitalisation and deprivation in New Zealand

	Deprivation Quintiles						
Years	**1 Least Deprived**	**2**	**3**	**4**	**5 Most deprived**	**Absolute difference Q5-Q1**	**Relative Inequality Ratio Q5/Q1**
1999	20.9	27.1	35.7	41.9	57.6	36.7	2.8
2000	18.9	24.9	31.8	36.1	48.8	29.9	2.6
2001	21.9	31.8	39.0	45.2	59.1	37.2	2.7
2002	21.6	28.8	36.5	42.8	57.5	35.9	2.7
2003	20.4	27.9	35.3	44.1	58.7	38.3	2.9
2004	20.2	25.3	32.7	43.4	63.3	43.1	3.1
2005	20.8	28.1	35.9	45.1	65.3	44.5	3.1
2006	24.6	29.6	37.9	46.7	70.0	45.4	2.8
2006-1999	**3.7**	**2.5**	**2.2**	**4.5**	**12.4**	**8.7**	

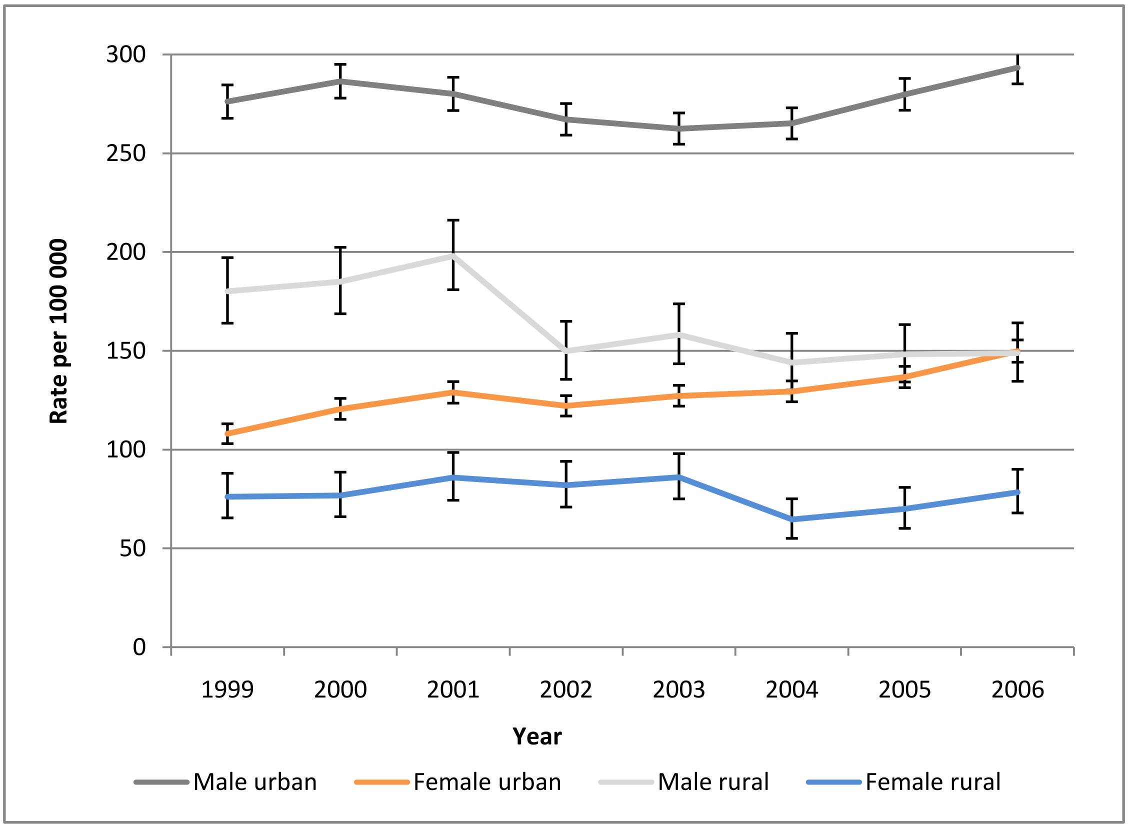
Further analysis was undertaken to examine the ratios (Q5/Q1) and differences (Q5-Q1) between quintiles five and one, for an indication of both relative and absolute inequality (Table 5.5). Relative inequality has been used to compare resources available in the most deprived areas compared to the least deprived (Pearce et al., 2008). Absolute inequality is used to measure the differences in diseases in the most and least deprived. Table 5.5 shows that all the ratios (relative inequality) are about three. With the exception of 1999 and 2006, the gap has widened between quintile five and one over the years. As deprivation increases, rates of hospitalisation also increase. The differences in absolute inequality shows that from 1999, the difference between Q5 and Q1 has increased from 36.7 to 45.4, indicating that while relative inequality remained almost the same, there was actually more increase in hospitalisation in the least deprived areas, and the gap has widened over time. Most importantly, absolute inequality in hospitalisation increased from 1999 to 2006 by about 24%. While there was a slight reduction in 2000, the differences have been high at slightly over 35 per 100 000 persons. The increase for the least deprived over the years (2006-1999) was only 3.7 compared to 12.4 for the most deprived

5.2.5 Hospitalisation trends by urban/rural location

Rural and urban locations have shown differing rates of alcohol-related hospitalisation in many different parts of the world (Hanlin et al., 2000, Kristina et al., 2004, Stickley et al., 2009). This is also true for New Zealand where male and female alcohol-related hospitalisation rates for rural areas are below the average for the country as a whole. There has been a slight increase in the urban male rates between 1999 and 2006, despite a slight decline in between, while the rural male rates have declined substantially from 180 to 148 per 100 000. Similar trends are observed in female rates. Urban females experienced a gradual increase, while for their rural counterparts, rates declined from 2004 onwards. Interestingly, in 2006, hospitalisation rates for both rural males and urban females were the same, with low confidence intervals for urban females and high confidence intervals for rural males. This is because the rates for rural men decreased while the rates for urban women increased from about 100 to 147 per 100 000. Rates for both rural males and females have slightly higher confidence intervals than for urban males and females. Such confidence intervals illustrate that rates in urban areas were more stable that the rural areas. It is anticipated that, if the same trend continues, urban females will soon have higher rates than rural men.

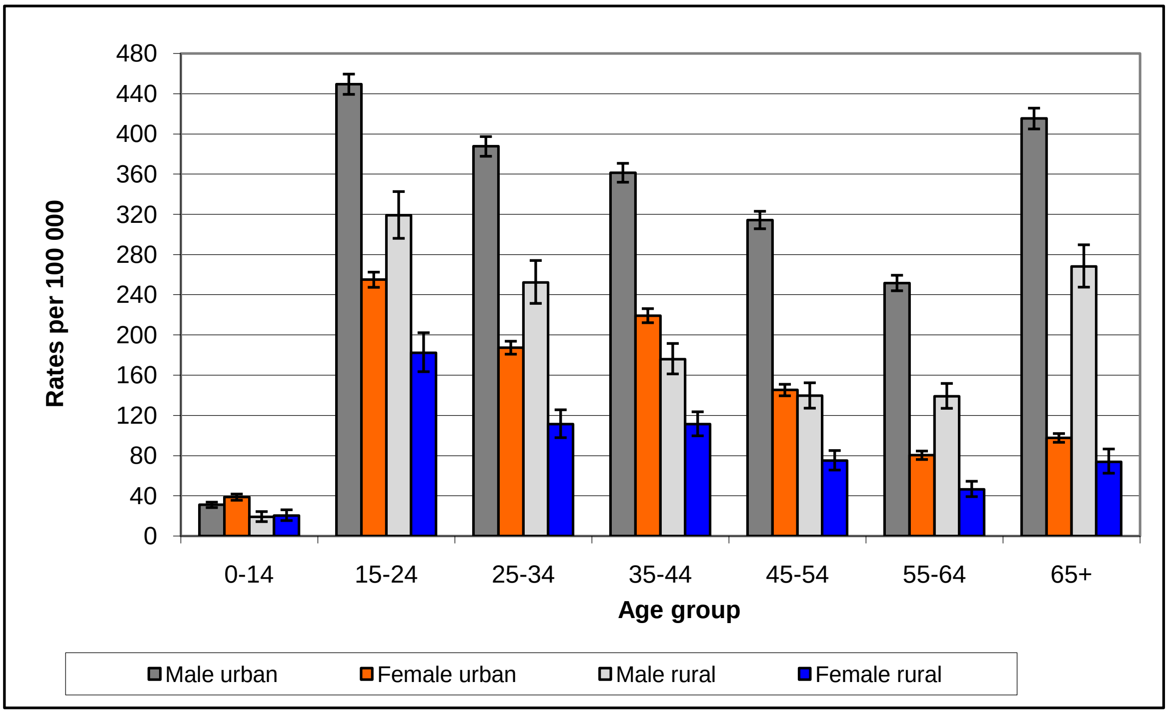
The gap between urban and rural rates has increased with time. A comparison of urban and rural men over the years shows a widening gap and this was also true for urban and rural females. As shown in earlier in Figure 5.1, the gap between males and females decreased slightly over the years.

Figure 5.9: Age-standardised alcohol-related hospitalisation rates by male and female for urban and rural areas in New Zealand



To better understand gender differences in urban and rural rates, further analysis was undertaken for different age groups. Figure 5.10 illustrates the variations and as expected male rates were higher in all age groups. The female rates were higher only in the 0–14 age group. A surprising result was in the age group 35–54 years, where urban females have higher rates than rural males, probably a reason for earlier gender results in Figure 5.9. As in the other analyses, the highest hospitalisation rates were for those aged 15–24 for both males and females in both urban and rural areas, however

Figure 5.10: Age-specific alcohol related standardised hospitalisation rates for urban and rural by age for years 1999–2006 in New Zealand



the rural rates for both males and females have higher confidence intervals and are therefore not stable.

Figures 5.11 and 5.12, shows the urban and rural ratios of males and females. The differences between urban and rural males have been fluctuating for the younger age group 15-24. Only middle-aged males aged 45–64 have shown a consistent upward trend throughout the period, with differences in hospitalisation rates between the age groups widening over time. Earlier results in Figure 5.9 and Figure 5.10 illustrated that rates for rural males have slightly higher confidence intervals than those in urban areas.

Figure 5.11: Ratio between urban and rural males by year in New Zealand

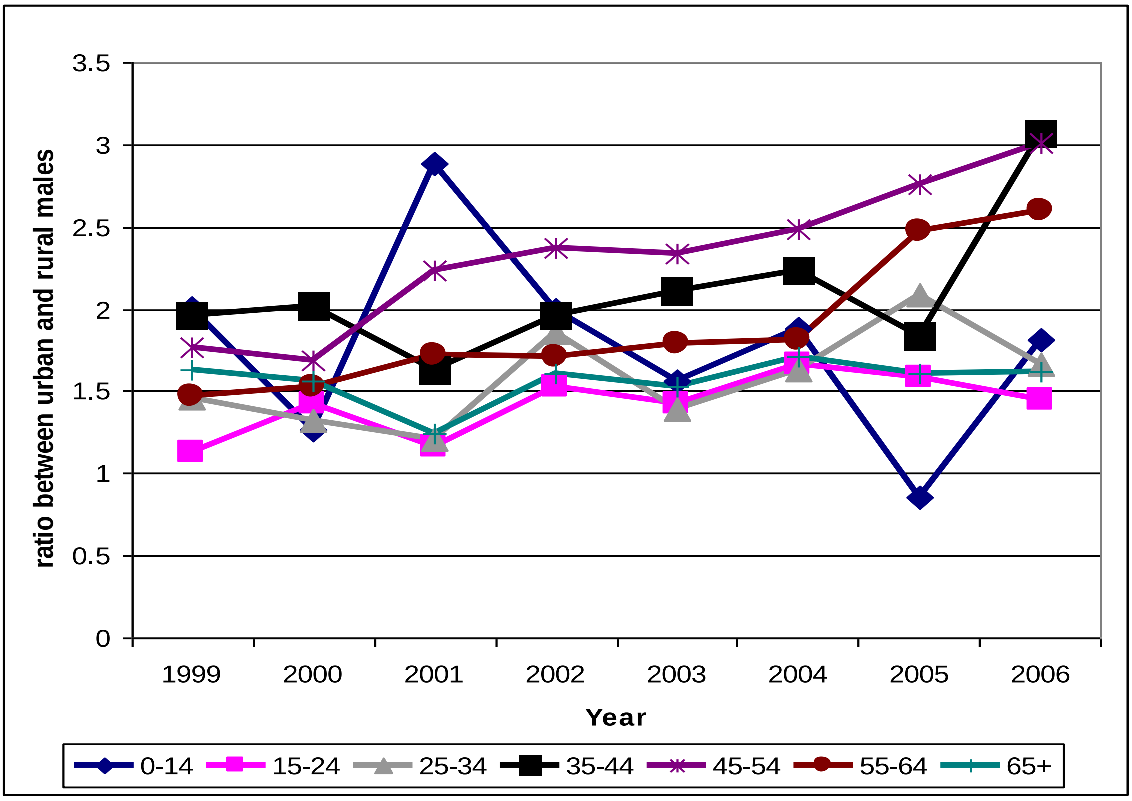
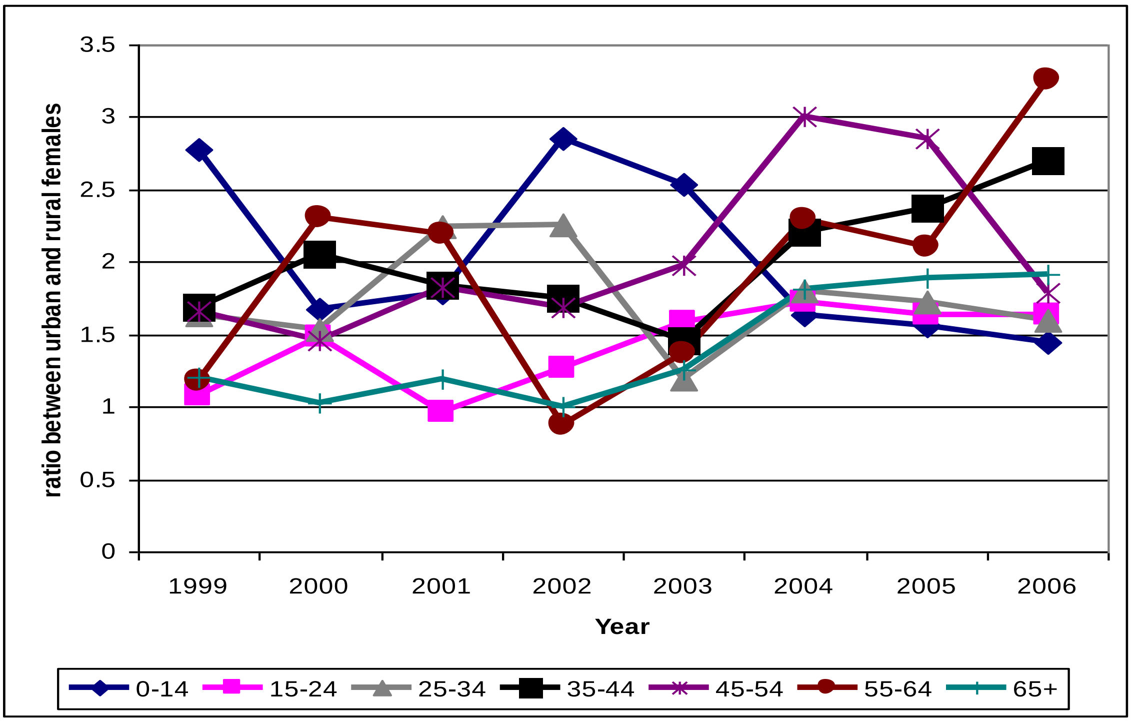


Figure 5.12: Ratio between urban and rural females by year in New Zealand



Further analysis was undertaken to examine the differences between urban and rural genders and age groups and any percentage increases over the years. This analysis was undertaken because Figure 5.11 shows that the urban males have higher hospitalisation rates. Appendix 6 shows that the highest increase in hospitalisations was in the younger 15–24 year age group. Urban male rates increased from 43 to 63 per 100 000, an increase of 69%. This percentage was the highest increase for all age groups. For rural males, all age groups show a decline, except for the younger age group (15–24 years) who recorded an increase; however the highest decline of 47.8 is in the middle aged (55–64 years) (Appendix 6).

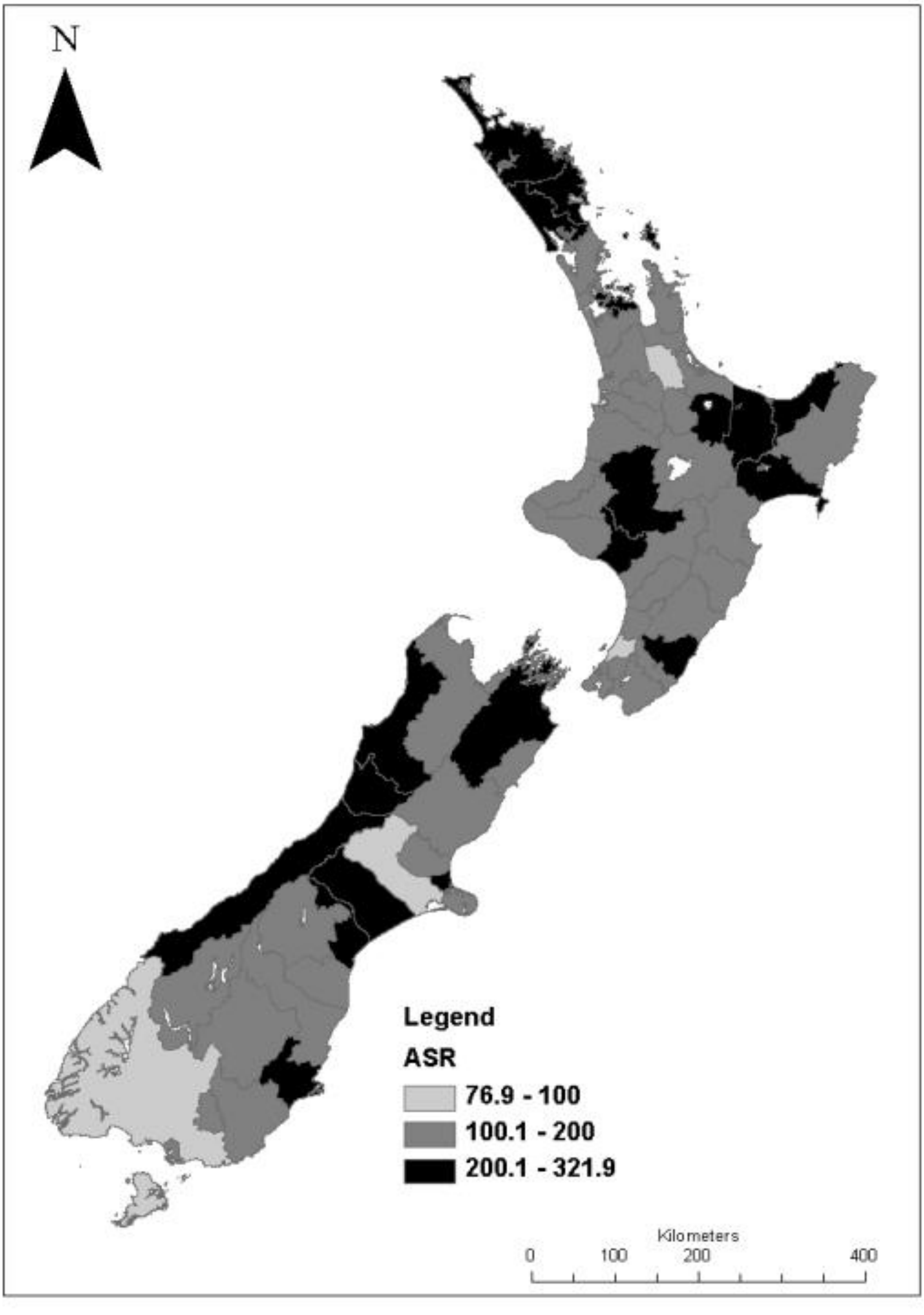
A similar analysis was undertaken to examine the differences in females as they present a different trend from the one observed for males. Both urban and rural females aged 15–24 experienced an increase in hospitalisation rates over the years (1999–2006) with urban female rates almost doubling. For females, there was a decline but only for 35–44 and 55+ age groups (Appendix 7).

5.2.6 Geography of alcohol-related admissions

The previous results in Section 5.2 have shown that alcohol-related hospitalisations show varying patterns when analysed by age groups, gender, ethnicity, deprivation and urban/rural location. Sometimes these differences are manifested at the TA level, where those residing in certain areas have higher than average rates; therefore, to examine geographical differences, indirect standardised rates were calculated for TAs for 1999-2006. The analysis is purely descriptive and examined differences at TA level only and highlights areas with higher than average rates.

As illustrated in Chapter 4, indirect standardised rates were calculated for all TAs. Standardised rates of hospitalisation were arrived at by first calculating ASIRs for each age group by dividing the total observed cases by the total population from the census and multiplying the result by 100 000 within each TA. The ASIRs were then multiplied by the population in the corresponding age group and summed to give the expected number of cases. SIRS are finally calculated by dividing the observed from the expected cases. The result is interpreted as follows. If the SIR is = > 100, the study population had less or the same risk of disease as the standard population.

Figure 5.13: New Zealand territorial local authorities age-standardised hospitalisation rates per 100 000 (1999–2006)



However, if the SIR < 100, then the study area's incidence is greater than that of the standard population (Moon et al., 2000). Figure 5.13 shows the different districts with hospitalisation rates ranging from 76.9 to 321.9 per 100 000. Over 90% of TA's had rates higher than what was expected of the standard population. There are however TA's with much higher than expected rates, greater that 200 per 100 000. These occurred in: Auckland, Christchurch, Opotiki, Kaipara, Ruapehu, Westland, Kawerau, Wanganui, Far North, Grey, Buller and Whangarei districts. Most of the TLAs with higher than average rates are located in the North Island thus showing that higher rates of hospitalisations are in this region. These results show that there is spatial variation in alcohol related hospitalisations. At this broader TA level, however, it is very difficult to explain the variation, especially since TAs are heterogeneous, containing people of different backgrounds. The explanation lies partly in the individual factors including age, gender, ethnicity, socio-economic status and urban/rural location as well as historical and cultural reasons. These factors interact within the TAs and the socio-demographic characteristics examined earlier could be possible reasons for higher than average rates in some TAs. If the rates for gender, age and ethnicity are the same for all the people, then the assumption can be made that the rates within the TAs should be the same, however the rates are different. Each TA has different contextual factors and the difference in rates suggests that contextual factors may also partly explain the geographical variation.

This study is more interested in the contextual factors that facilitate hospitalisations in deprived areas, and the driver for this relationship is unknown. Difference in ease of access to alcohol outlets has been suggested as one of the reasons. Regression analysis was undertaken to ascertain whether hospitalisation, as a proxy for hazardous consumption, also follows the trend of higher rates for the most deprived after controlling for confounding factors and could therefore be a possible reason for the geographical differences.

5.3 Predicting hospitalisation trends by deprivation after controlling for confounding factors

The results in Section 5.2 showed that those living in areas with the highest quintiles were three times more likely to be hospitalised that those living in lower quintile areas.

However, the results also indicated that individual factors are important in explaining some of the observed variations. This section therefore aims to understand whether these deprived areas have higher rates after controlling for all the other factors that are also associated with consumption namely age, gender, urban/rural location and ethnicity. The research question is;

- Do the rates of alcohol-related hospitalisations vary by deprivation after controlling for potential confounding individual characteristics?

Poisson regression was undertaken to determine whether deprivation is important in predicting alcohol-related hospitalisation after controlling for a number of ‘composition’ and ‘place’ effects. The data for this analysis were raw individual counts across all age groups, broken down by gender, urban/rural location and deprivation in each CAU as described in Chapter 4. For ethnicity, data were only available for a percentage of European New Zealanders, and not for other ethnic groups.

The data was first divided into two periods 1999–2002 and 2003–2006 to establish if there were any differences between the two periods and ascertain whether there was a decrease, or an increase, in rates between the baseline, quintile 1 and other quintiles. Poisson regression was used for this analysis as it (Poisson regression) provides good comparisons between the variables while showing Incidence Rate Ratios (IRRs) and Low Confidence Intervals (LCI) and Upper Confidence Intervals (UCI).

Tables 5.6 and 5.7 show the regression analysis for the two different periods in the study, 1999–2002 and 2003–2006. The main study factor is deprivation and therefore changes within deprivation quintiles were monitored as different control variables were added. For both periods the rates in the most deprived areas were consistently higher before any adjustment. There was a social gradient with rates in ascending order from the least deprived quintile which is the baseline or reference group, to the most deprived quintile which has rates almost three times higher than the least deprived (Model 1). The IRRs in each quintile are statistically significant and strong ($p < 0.0001$). Moreover, within the two periods, there was an increase in rates for the most deprived quintile and decrease in the second least deprived quintile.

Table 5.6: Regression modelling for alcohol-related hospitalisation 1999–2002

	Model 1				**Model 2**				**Model 3**				**Model 4**			
	NZ deprivation			P value	Gender/Age			P value	Rural/urban			P value	Ethnicity			P value
	IRR	LCI	UCI		IRR	LCI	UCI		IRR	LCI	UCI		IRR	LCI	UCI	
Quintile 1-least deprived	**1**				**1**				**1**				**1**			
Quintile 2	**1.44**	1.38	1.51	**0.00**	**1.44**	1.37	1.51	**0.00**	**1.46**	1.39	1.53	**0.00**	**1.46**	1.40	1.54	**0.00**
Quintile 3	**1.82**	1.74	1.91	**0.00**	**1.80**	1.72	1.88	**0.00**	**1.78**	1.70	1.86	**0.00**	**1.80**	1.72	1.89	**0.00**
Quintile 4	**2.10**	2.01	2.20	**0.00**	**2.09**	2.00	2.19	**0.00**	**2.03**	1.94	2.12	**0.00**	**2.08**	1.98	2.17	**0.00**
Quintile 5-most deprived	**2.71**	2.60	2.83	**0.00**	**2.82**	2.70	2.94	**0.00**	**2.73**	2.61	2.85	**0.00**	**2.90**	2.76	3.05	**0.00**
Gender																
Female					**1**				**1**				**1**			
Male					**2.30**	2.25	2.36	**0.00**	**2.31**	2.25	2.37	**0.00**	**2.31**	2.26	2.37	**0.00**
Age groups																
65+					**1**				**1**				**1**			
55–64					**0.82**	0.78	0.86	**0.00**	**0.83**	0.79	0.87	**0.00**	**0.83**	0.79	0.87	**0.00**
45–54					**0.77**	0.74	0.81	**0.00**	**0.78**	0.75	0.82	**0.00**	**0.79**	0.75	0.82	**0.00**
35–44					**0.81**	0.78	0.84	**0.00**	**0.81**	0.78	0.85	**0.00**	**0.82**	0.79	0.85	**0.00**
25–34					**0.88**	0.84	0.91	**0.00**	**0.88**	0.84	0.91	**0.00**	**0.88**	0.85	0.92	**0.00**
15–24					**1.05**	1.01	1.09	**0.02**	**1.04**	1.01	1.09	**0.03**	**1.05**	1.01	1.09	**0.01**
0-14					**0.08**	0.07	0.08	**0.00**	**0.08**	0.07	0.08	**0.00**	**0.08**	0.07	0.08	**0.00**
Urban/Rural																
Urban									**1**				**1**			
Rural									**0.74**	0.71	0.77	**0.00**	**0.73**	0.70	0.76	**0.00**
% European Ethnicity													**1**	1	1	**0.00**

LCI-Lower Confidence Intervals

UCI-Upper Confidence intervals

Bold figures indicate statistically significant associations (p <0.05)

Table 5.7: Regression modelling for alcohol-related hospitalisation 2003-2006

	Model 1				**Model 2**				**Model 3**				**Model 4**			
	NZ deprivation			p value	Gender/Age			p value	Rural/urban			p value	Ethnicity			p value
	IRR	LCI	UCI		IRR	LCI	UCI		IRR	LCI	UCI		IRR	LCI	UCI	
Quintile 1-least deprived	**1**				**1**				**1**				**1**			
Quintile 2	**1.30**	1.24	1.37	**0.00**	**1.30**	1.24	1.36	**0.00**	**1.33**	1.27	1.39	**0.00**	**1.35**	1.29	1.41	**0.00**
Quintile 3	**1.70**	1.62	1.77	**0.00**	**1.68**	1.61	1.75	**0.00**	**1.65**	1.58	1.73	**0.00**	**1.72**	1.64	1.79	**0.00**
Quintile 4	**2.13**	2.05	2.23	**0.00**	**2.12**	2.03	2.21	**0.00**	**2.02**	1.94	2.11	**0.00**	**2.17**	2.08	2.26	**0.00**
Quintile 5-most deprived	**2.97**	2.86	3.10	**0.00**	**3.03**	2.91	3.16	**0.00**	**2.90**	2.79	3.02	**0.00**	**3.45**	3.29	3.62	**0.00**
Gender																
Female					**1**				**1**				**1**			
Male					**2.04**	2.00	2.09	**0.00**	**2.06**	2.01	2.11	**0.00**	**2.06**	2.01	2.11	**0.00**
Age groups																
65+					**1**				**1**				**1**			
55–64					0.99	0.95	1.04	0.73	1.01	0.96	1.05	0.78	1.02	0.97	1.06	0.45
45–54					**0.94**	0.90	0.98	**0.01**	**0.95**	0.91	0.99	**0.03**	0.97	0.93	1.01	0.12
35–44					1.00	0.96	1.04	0.91	1.01	0.97	1.05	0.68	1.03	0.99	1.07	0.18
25–34					**1.09**	1.05	1.14	**0.00**	**1.09**	1.04	1.13	**0.00**	**1.11**	1.07	1.16	**0.00**
15–24					**1.54**	1.48	1.60	**0.00**	**1.53**	1.47	1.59	**0.00**	**1.56**	1.50	1.62	**0.00**
0-14					**0.06**	0.06	0.07	**0.00**	**0.06**	0.06	0.07	**0.00**	**0.07**	0.06	0.07	**0.00**
Urban/Rural																
Urban									**1**				**1**			
Rural									**0.62**	0.60	0.65	**0.00**	**0.61**	0.59	0.64	**0.00**
% European Ethnicity													**1**	1	1	**0.00**

LCI-Lower Confidence Intervals

UCI-Upper Confidence intervals

Bold figures indicate statistically significant associations (p <0.05)

With the introduction of the control variables, age and gender (Model 2), there was a marginal change in the deprived quintiles, for both the first and second period, showing that age and gender did not have much influence on the rates of hospitalisation for both periods, despite a stronger social positive gradient in admission for males in earlier results (Section 5.2).

The results were statistically significant ($p < 0.001$) for all quintiles, and illustrate that deprivation is important in explaining the difference in hospitalisation even after controlling for gender and age. Male rates of admission were twice as high as women, however by the second period there was a slight reduction, estimated at 11%. The male rates were statistically significant for both periods ($p < 0.001$).

The analysis by age showed that the 65 and over age group has the highest IRRs, except for those aged 15–24. In the second period, the age range with the higher rates expanded to 15-34, indicating that the rates for people aged 15–34 increased while the age group 65+ recorded a decline. Between the two periods the age group 15–24 recorded an increase of 46%. While all age groups were statistically significant in the first period ($p < 0.05$), the age groups 35–44 and 55–64 were not statistically significant in the second period.

Adding the control variable for urban and rural location to the model produced an interesting relationship (Model 3). There was a slight increase in IRRs in the affluent quintile 2, while poorer quintiles recorded a decline in IRRs. Urban and rural location mediates in the relationship between deprivation and hospitalisation, because most of the admissions are from deprived neighbourhoods in urban areas. Rates were increased for both male and female 25-44 year olds, while for male and females over 65 the rates decreased. The IRRs were higher in urban than rural areas by 38% in the second period compared to 26% for the first period, indicating an increasing polarisation within the two areas.

When the final control, percentage of European ethnicity was added, the changes by deprivation quintiles varied again (Model 4) as there were minimal increases in IRRs for quintile five within the first period, but a significant increase within the second period. The analysis controlled for percentage of European ethnicity. Some of the variations observed in deprived quintiles can be partly explained by ethnicity, which is not surprising given the fact most ethnic groups who live in deprived neighbourhoods have the highest rates of hospitalisation (Craig and Jackson, 2006, NHS 2010). The age and gender rates remained almost the same within the both periods. Similarly, the urban/rural change was minimal.

The regression results show that deprivation, the main study factor, explains the differences observed in hospitalisation rates and those living in the most deprived areas have higher rates than those living in the least deprived areas, even after taking into consideration all the other control variables. There was a slight increase over time for the deprivation quintiles four and five, and a slight decline over time for deprivation quintiles two and three, which are more affluent. Similar results were observed for gender, where the male rates were consistently twice as high as the female rates within the first period, and the IRRs decreased slightly within the second period. In short, while there was an increase in deprivation differences within the years, the gender difference declined.

The hospitalisation rates were higher in the 15–24 age group for both periods; however rates were increased for age groups 25-44, both males and females, while for those aged 65 the rates declined (owing to an increased rate of hospitalisation in the younger age groups and a decline in the older age groups). The gap between rural and urban hospitalisation rates increased slightly between the two periods. No further analysis was done on the interactions between the different variables as the main focus was on the changes occurring within the deprivation quintiles. The aim of this study was to explain the 'place' effects related to alcohol consumption rather than focussing on different individual variables. Most importantly, the regression analysis showed that the differences between deprivation quintiles widened over time, maybe because of contextual factors, while the difference between males and females decreased.

5.4 Summary

This analysis has revealed five themes. Hospitalisation was characterised by differences in age, gender, ethnicity, urban/rural location and SES. Younger males and females aged 15–24 had the highest rates of hospitalisation compared to all other ages while the rates for older people aged 65 years and over declined. Analysis for gender showed that male hospitalisation rates were consistently higher than female rates, but these rates have been increasing faster than male rates over the years. In effect, the gender gap has narrowed over time. Result for ethnicity revealed that Māori had double the non-Māori rates. The urban rates were consistently higher than rural rates and that difference has widened over time. The rates also differed by socio-economic status, with higher rates of hospitalisation in the most deprived groups when compared to the more affluent. The regression analysis also found that rates within the most deprived areas increased over time after controlling for a range of confounding variables, showing increased polarisation over time. Explanations of these results will be presented in Chapter 9.

The geographical differences in hospitalisation rates were attributed to age, gender, ethnicity, urban/rural location and SES. Regression analysis indicated that those living in the most deprived areas were three times more likely to be hospitalised than those living in the least deprived quintile, after controlling for other individual variables. This suggests that research needs to establish the reasons for the high rates of hospitalisation in deprived areas by examining contextual factors, such as access to alcohol outlets. Before discussing that issue the next section investigates the other potential proxy, alcohol-related mortality, to establish whether alcohol related mortality is influenced by similar factors to hospitalisation.

5.5 Descriptive trends in alcohol-related mortality

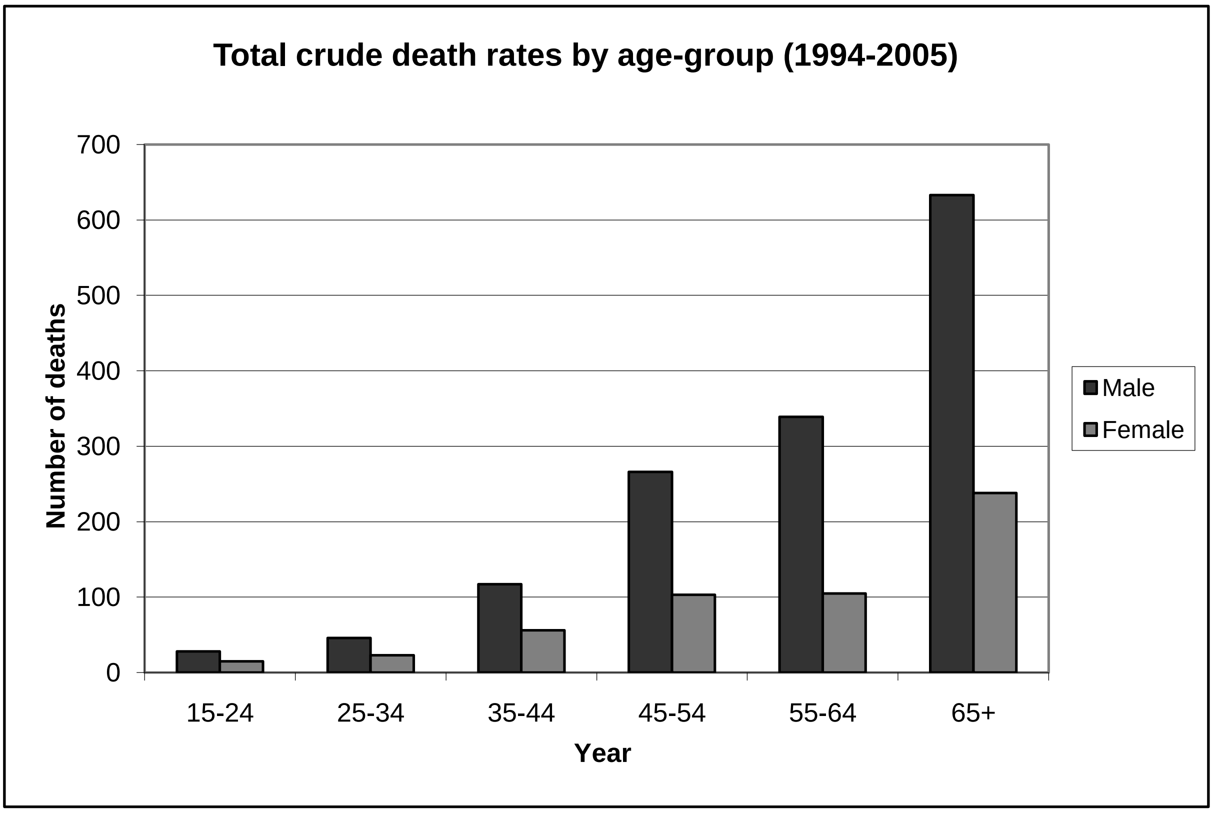
The previous section examined alcohol-related hospitalisation. This section will present similar results but for the second proxy measure of alcohol consumption, alcohol-related mortality. Similar to hospitalisation, this section has two aims. The first is to establish the geography of alcohol consumption for small areas in New Zealand. The second is to determine the spatial and temporal variations of mortality.

This section is organised as follows. The first section will report on the trends in mortality over time for different population groups. The geography of the different population groups will then be examined followed by a consideration of the extent to which mortality is predicted by deprivation after controlling for both compositional and location factors.

5.5.1 Total mortality

There are differences observed in males and females and Figure 5.14 shows the total mortality by gender by different age groups. Figure 5.14 shows the total alcohol-related deaths by gender indicating a gradient with low numbers in the younger age groups and higher numbers for the older age groups, with more deaths recorded for males than females.

Figure 5.14: Total crude alcohol-related deaths by age group (1994–2005) in New Zealand



The difference between crude male and female rates doubled by age 55–64, and tripled in the 65 years and over. Clearly, more males than females died from alcohol-related mortality and the gap widened with age. Local and international studies that examine alcohol-related mortality report that mortality for minor diseases, such as intoxication, is more prevalent amongst the younger age groups. However, the older age groups are more likely to die from serious conditions such as cirrhosis (Christie, 2008). Table 5.8 illustrates the differences in mortality by different diseases and age groups. Table 5.8 shows that the older age groups were more likely to die from serious alcohol-related

Table 5.8: Alcohol-related mortality by cause of death and age group in New Zealand (1994-2005)

Age group	Alcohol Psychoses	Accidental Alcohol Poisoning	Toxic effect of alcohol	Alcohol use disorder	Alcohol Cardiomyopathy	Alcohol gastritis	Alcohol Fatty Liver	Acute Alcohol Hepatitis	Alcoholic Cirrhosis of Liver	Alcohol Liver damage	Alcohol Dependence Syndrome	Acute Pancreatitis	Total
15–24	3	9	11	15	0	0	1	1	0	0	3	0	**43**
25–34	7	7	11	14	3	0	0	2	9	3	8	5	**69**
35–44	12	6	8	20	31	1	3	4	52	11	16	9	**173**
45–54	30	7	4	17	56	4	8	2	200	14	18	9	**369**
55–64	43	4	1	4	100	0	3	3	227	30	7	22	**444**
65+	109	2	8	1	136	4	5	8	378	43	20	157	**871**
Total	204	35	43	71	326	9	20	20	866	101	72	202	**1969**

disease such as cirrhosis of the liver and other liver diseases, alcohol cardiomyopathy, alcohol psychoses, acute pancreatitis and other diseases of the pancreas as well as alcohol dependency syndrome. The younger age group were more likely to die from accidental poisoning by alcohol, toxic effects of alcohol, and alcohol use disorder.

Table 5.9 shows different causes by gender, illustrates that men were more likely to die from most of the diseases than women, except for acute pancreatitis where women reported more cases over the period than men.

Table 5.9: Alcohol-related mortality by cause of death and gender in New Zealand (1994-2005)

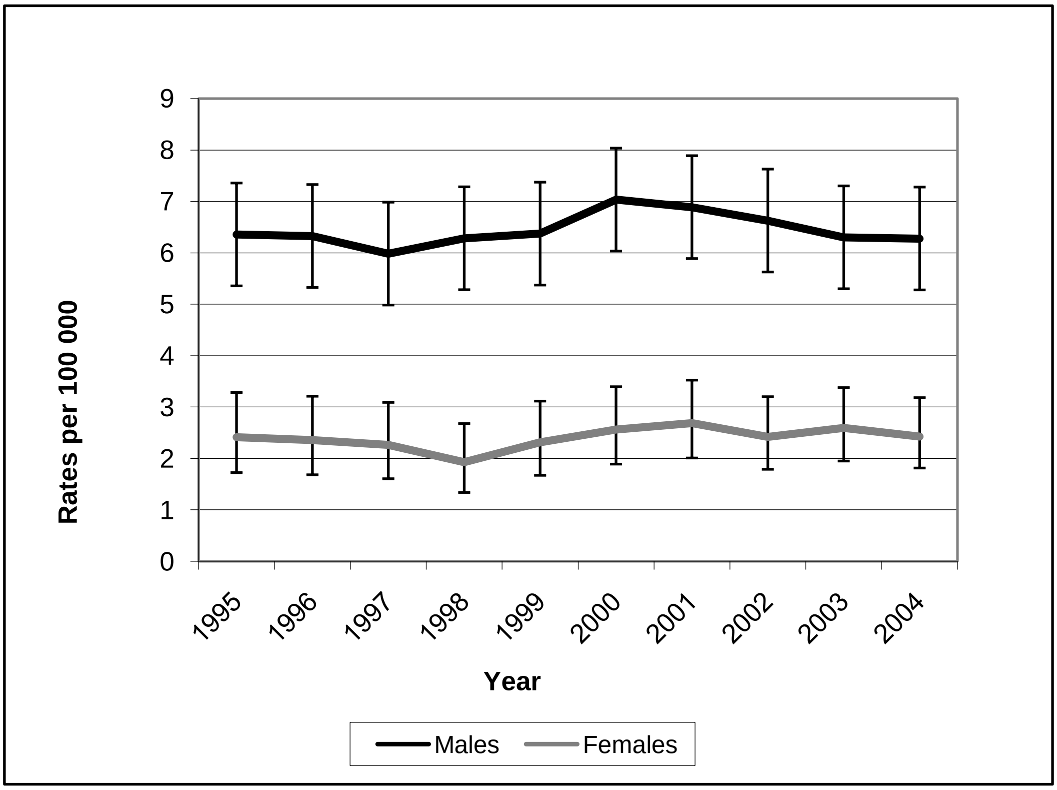
	Gender		
Cause of death	**Female**	**Male**	**Total**
Alcohol Psychoses	56	148	204
Alcohol Dependence Syndrome	22	50	72
Alcohol use disorder	24	47	71
Alcohol Cardiomyopathy	28	298	326
Alcohol gastritis	1	8	9
Alcohol Fatty Liver	11	9	20
Acute Alcohol Hepatitis	7	13	20
Alcoholic Cirrhosis of Liver	222	644	866
Alcohol liver damage	32	69	101
Toxic effect of alcohol	21	22	43
Acute Pancreatitis	108	94	202
Accidental Alcohol Poisoning	8	27	35
Total	**540**	**1 429**	**1 969**

5.5.2 Mortality trends by age and gender

As mortality rates fluctuate due to low numbers, all results are presented as moving three year averages. Similar to hospitalisation rates, mortality rates were age-standardised. Figure 5.15 shows that male mortality rates were three times higher than for females and despite a slight increase in the male rates, the gender gaps have remained relatively constant for most of the period, 1995-2005.

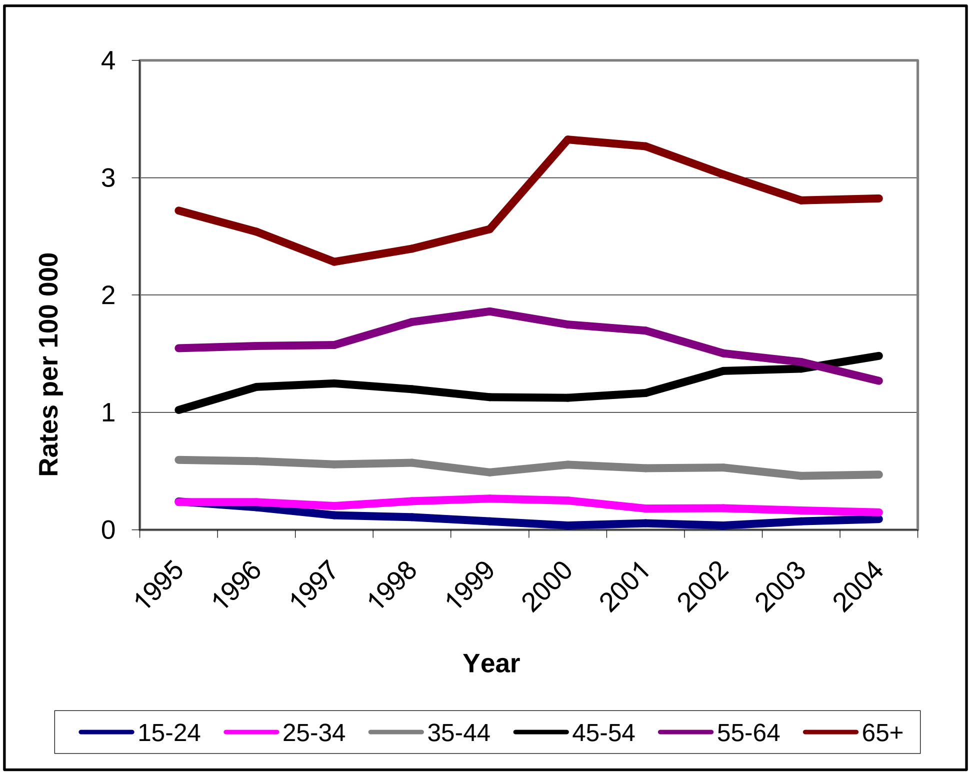
The age-standardised rates for alcohol-related mortality for the whole of New Zealand showed that the peak for males was 7 per 100 000 in 1999 and 2.5 per 100 000 for females in 2000. This result is not surprising since males have been reported to be more at risk of hazardous alcohol consumption than women (NZHS, 2006/2007; ALAC, 2008) and previous figures for hospitalisation revealed similar trends. Although the rates have higher confidence intervals, male rates are significantly higher than those for females.

Figure 5.15: Age-standardised alcohol-related mortality rates by gender in New Zealand



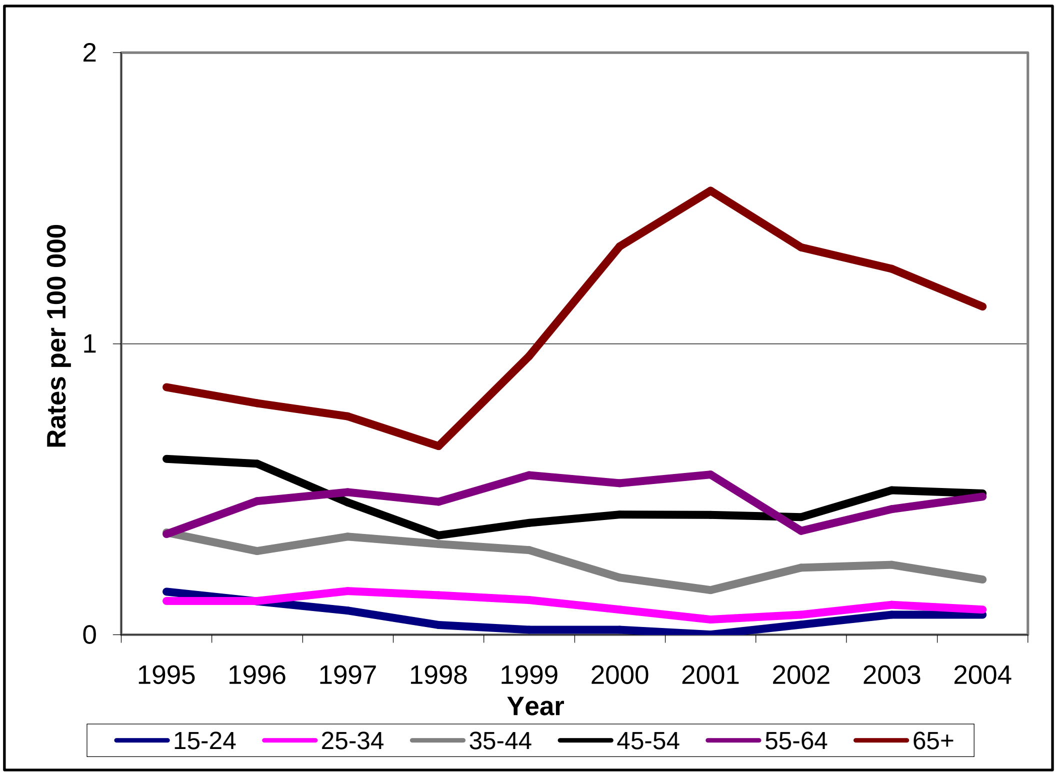
To better understand these gender differences in mortality, further analysis was undertaken to find out the distribution in the different age groups. Rates for males aged 65+ age increased from 2.5 (CI 1.9-3.4)per 100 000 in 1996 to 3.3 (CI 2.6-4.2) per 100 000 in 2000 (Figure 5.16). The gap between those aged 65 and above and 55–64 narrowed between 1997 and 1999, then widened again and remained almost the same for the rest of the period. However, because of large confidence intervals, the rates overlap for the age groups indicating that mortality rates between the two age groups were not stable. Most of the age groups recorded a decline in the last few years although the decline was minimal (see Appendix 8 for confidence intervals).

Figure 5.16: Three year moving average age-standardised alcohol-related mortality for males in New Zealand



Since the rates for mortality are very low, the temporal trends by age groups can be quite deceiving. For example, the female mortality rates indicate that from 1999 onwards there was an increase rates for those aged 65 years and over (Figure 5.17). The rates only increased from 0.6 (CI 0.3-1.1) to 1.5 (CI 1.0-2.2) per 100 000. However, there was an overall decline in all age groups. It is worth noting that the rates are low, with most age groups falling below 1 per 100 000, except for age 65 and over which is slightly over 1 per 100 000. Mortality deaths are very low amongst women and the rates have been fairly unstable throughout the period, with high confidence intervals (see Appendix 9 for confidence intervals).

Figure 5.17: Three year moving average age-standardised alcohol related mortality for females in New Zealand

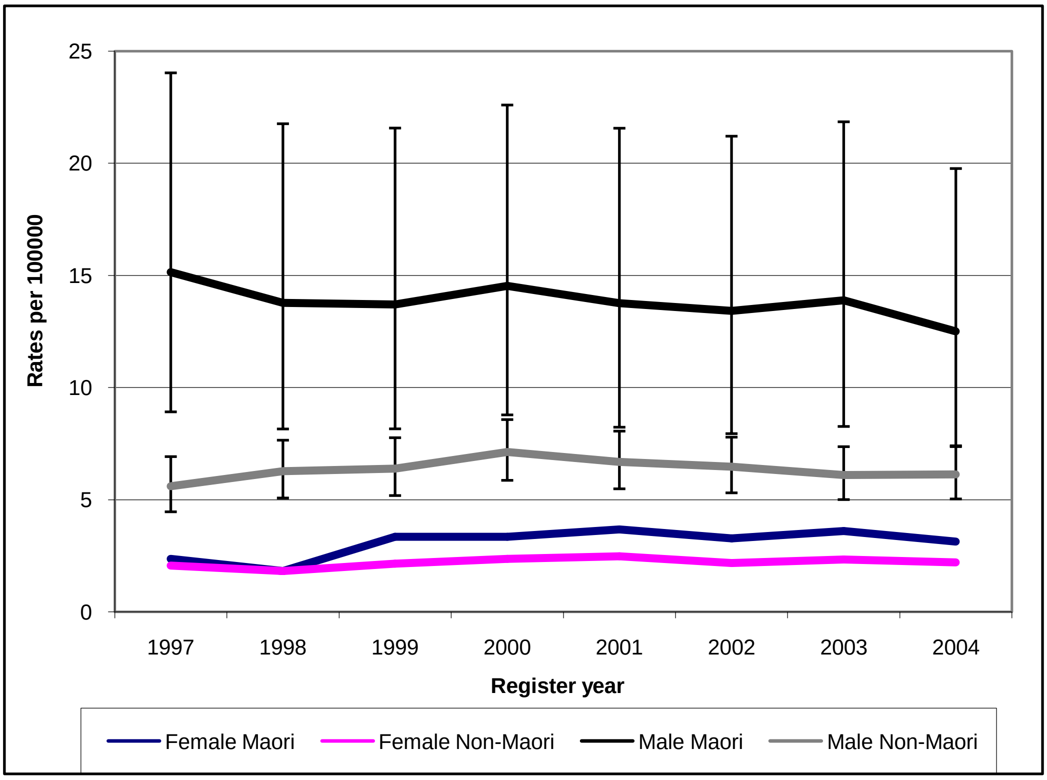


5.5.3 Mortality trends by ethnicity

Studies have shown that there are ethnic differences in mortality so this research also examines the differences in ethnic mortality. Note that in 1994 and 1995 the ethnicity of deaths was not recorded so these two years are omitted from the analysis.

Figure 5.18 indicates that Māori males were almost twice as likely to die from alcohol-related illness as non-Māori. While the rates have been fairly stable for non-Māori, the Māori rates have fluctuated over the years as illustrated by the high confidence intervals. Despite the fluctuations and high confidence intervals, male Maori rates are higher than non-Maori rates and there is overlap in the confidence intervals. Overall, there has been a decline in alcohol-related mortality for both Māori males and females, while for non-Māori males the rates have almost been constant throughout the 10 year period. These results are consistent with reports from ALAC (2008), which use data from Statistics New Zealand. For Māori females, whilst the rates have fluctuated over the years, the non-Māori female rates have remained relatively stable; however, the difference between them is minimal as the confidence intervals overlap (see Appendix 10 for female confidence intervals).

Figure 5.18: Three year moving average age-standardised specific mortality rates for Māori and non-Māori in New Zealand indicating confidence interval for males.



5.5.4 Mortality trends by deprivation

Figure 5.19 shows that there is a social gradient in alcohol-related mortality. The rates for the most deprived are consistently higher than the least deprived for all the years. In 1994, the third quintile had the highest rates, however quintile five still had higher rates that quintile one, but the confidence intervals overlap, indicating no significant differences. Similarly, analyses for different sub-populations by gender show that whilst there is a gradient for both males and females, the male rates are consistently higher. This relationship was not consistent for all the years (Figure 5.20). The mortality rates indicate that typically there are fewer females than males in deprivation quintiles 1-5. However for both males and females, the gradient is inconsistent and varies between the different quintiles. For example, for females in quintile 3 and 4 tend

Figure 5.19: Alcohol-related mortality rates per 100 000 population by deprivation quintiles in New Zealand

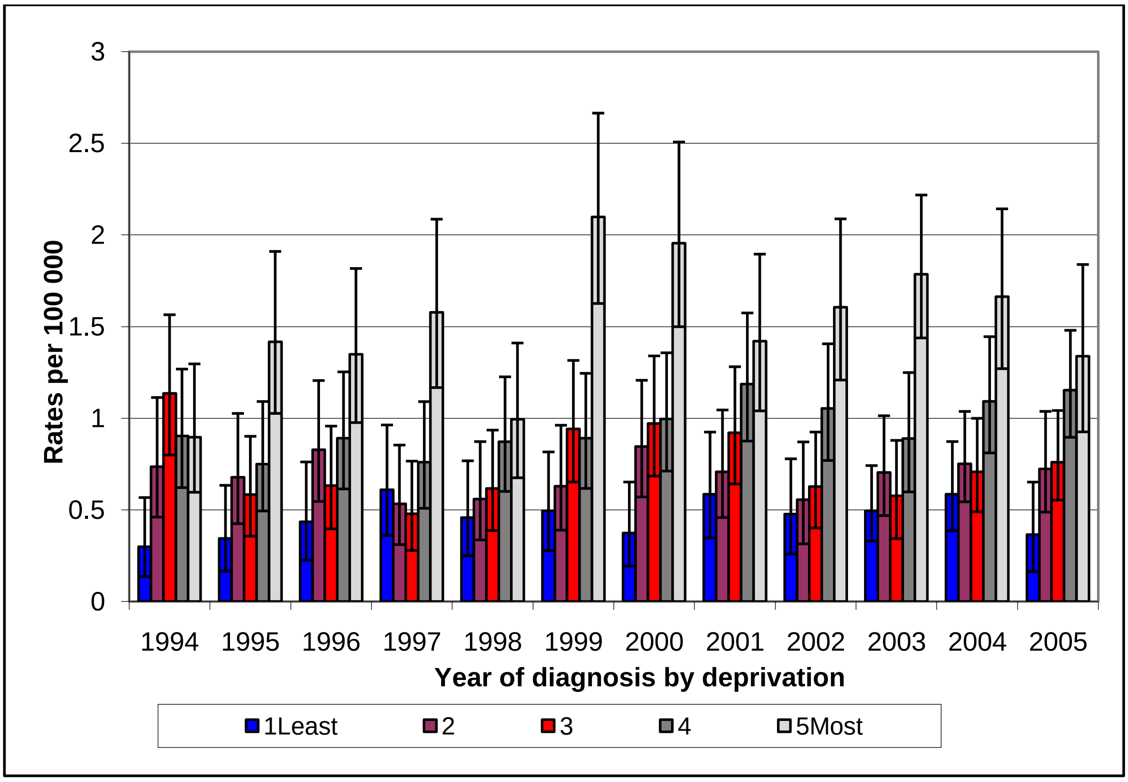
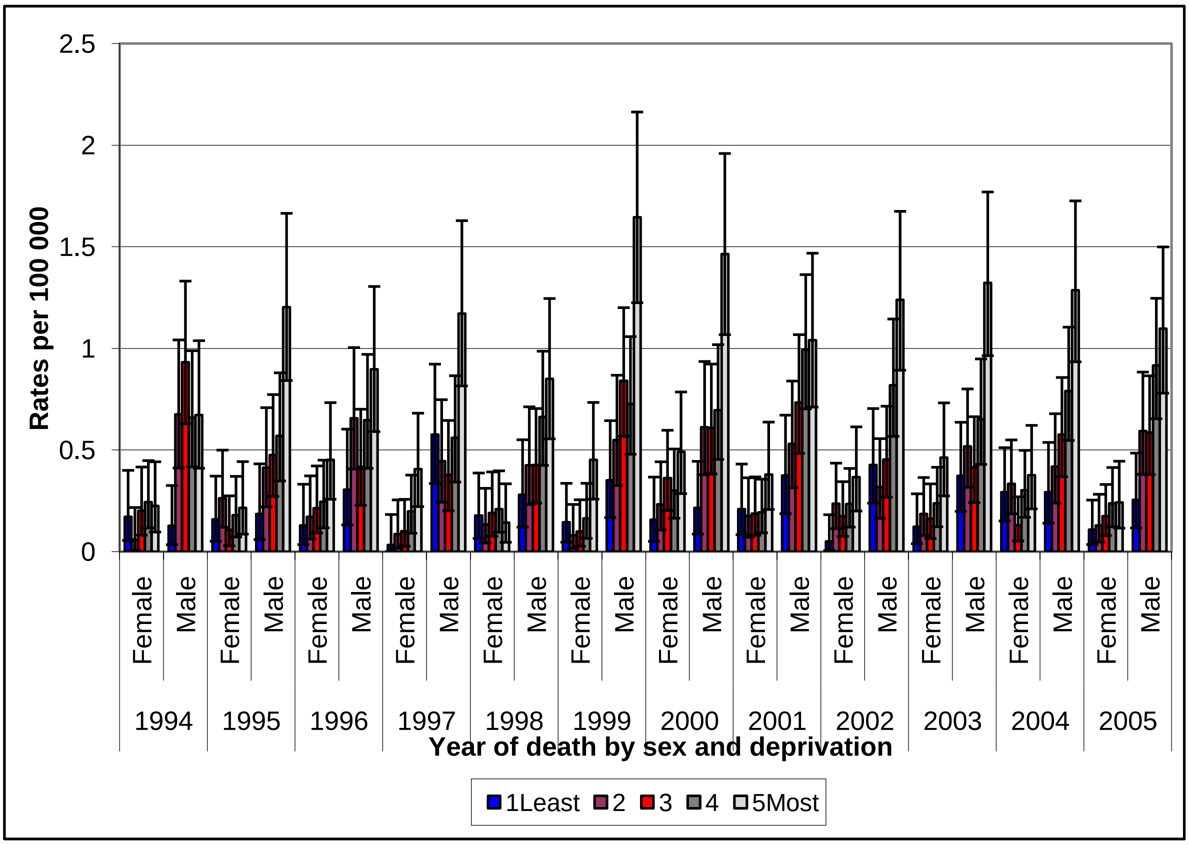


Figure 5.20: Alcohol-related mortality rates per 100 000 population in deprivation quintiles by gender in New Zealand



to have higher rates although the confidence intervals overlap. Earlier review in Chapters 2 and 3 had also shown that more females in higher SES tend to consume more alcohol that those in lower SES (Burger and Mensink, 2004, Emslie et al., 2002)

When yearly differences were examined, quintile five (the most deprived) was consistently associated with more mortality cases (Table 5.10) than quintile one. The increase has not been consistent over the years with fluctuations between the lowest (2.2) and the highest (5.2). However, the mortality rates are so low that sometimes a small difference may show three-fold effect for example in 1999 the rate in quintile one was 0.3 and the rates in quintile five 0.9.

Table 5.10: Ratio of standardised mortality rates per 100 000 population (using 2001 population as standard) and deprivation in New Zealand

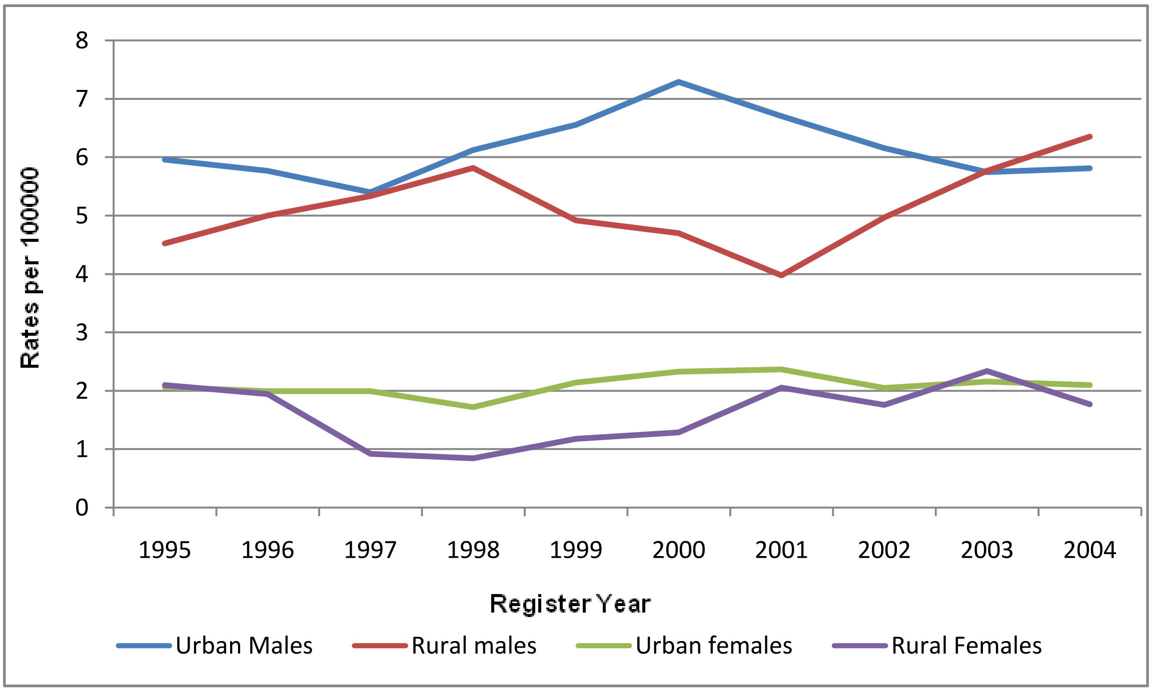
	Deprivation quintiles					
	1Least deprived	**2**	**3**	**4**	**5Most deprived**	**Ratio Q5:Q1**
1994	0.3	0.7	1.1	0.9	0.9	3.0
1995	0.3	0.7	0.6	0.7	1.4	4.1
1996	0.4	0.8	0.6	0.9	1.3	3.1
1997	0.6	0.5	0.5	0.8	1.6	2.6
1998	0.5	0.6	0.6	0.9	1.0	2.2
1999	0.5	0.6	0.9	0.9	2.1	4.2
2000	0.4	0.8	1.0	1.0	2.0	5.2
2001	0.6	0.7	0.9	1.2	1.4	2.4
2002	0.5	0.6	0.6	1.1	1.6	3.4
2003	0.5	0.7	0.6	0.9	1.8	3.6
2004	0.6	0.8	0.7	1.1	1.7	2.8
2005	0.4	0.7	0.8	1.2	1.3	3.7

5.5.5 Mortality trends by urban/rural location

There are studies that have shown that alcohol-related mortality varies between urban and rural areas (Chikritzhs et al., 2003). To answer the research question on whether there are urban and rural differences, mortality data was stratified by urban/rural location. Similar to deprivation, the analyses examined the extent to which absolute rates increased or decreased in different groups and whether the rates have increased over time.

Figure 5.21 illustrates that the rates for both urban and rural areas have been increasing and decreasing at different times. While rural rates rose from 2001 onwards, the urban rates declined from 2000-2005. Male rates were consistently higher than female rates. One surprising result is that in 2003 the rural male mortality rates for the first time were higher than the male urban rates. However, the rural have higher confidence intervals than urban male rates. This increase in rural males is surprising, despite the high confidence intervals, because the results in the previous section showed that people living in urban areas were more likely to be hospitalised than their rural counterparts (see Appendix 11 for confidence intervals).

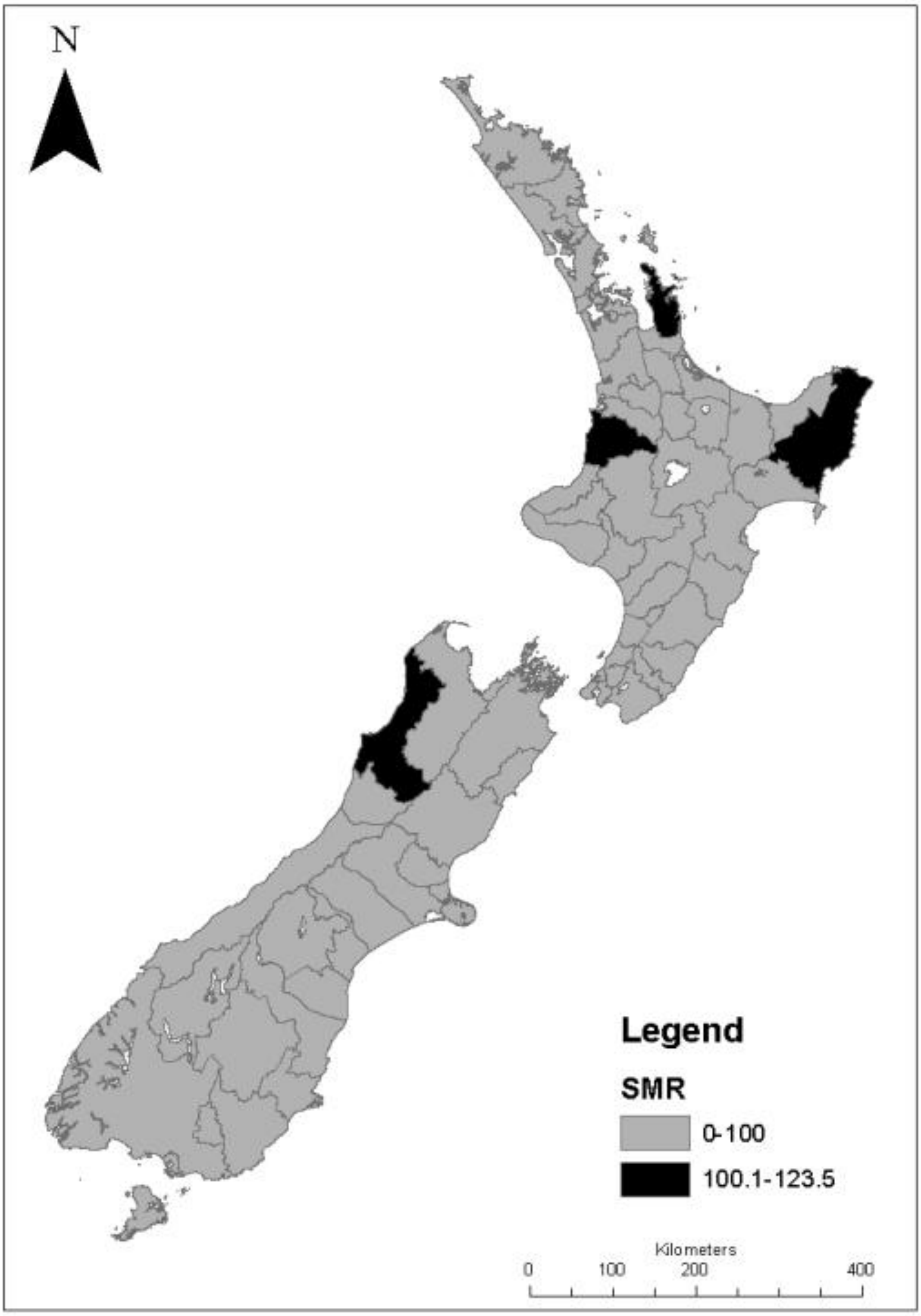
Figure 5.21: Three year moving averages for age-standardised rates of alcohol-related mortality for males and females and urban/rural location in New Zealand



5.5.6 Geography of alcohol-related mortality

To examine whether there are geographic patterns of alcohol-related diseases age-standardised rates were calculated for all the TAs and mapped. In Figure 5.22, TAs are mapped indicating rates which are below and above average. Only four districts have rates that are above the average SMS of 100.

Figure 5.22: New Zealand territorial local authorities age-specific mortality rates per 100 000 (1994–2005)



The standardised rates ranged from zero to 123.5 per 100 000 in some TAs. The areas with above average rates included Gisborne, Thames-Coromandel, Waitomo and Buller districts. The spatial patterns show that the North Island has more areas above average compared to the South Island. Surprisingly, none of the big cities including Auckland (5.8 per 100 000), Christchurch (4.5 per 100 000), Dunedin (4.5 per 100 000), and Wellington (4.2 per 100 000), fall in the category of those above the average. These geographical variations require further analysis to understand the contextual factors in these different TAs that enhance excessive alcohol consumption and subsequent mortality.

5.6 Predicting mortality trends by deprivation after controlling for confounding factors

As in the analysis of hospitalisation, the important question of whether the rates of alcohol-related mortality vary by deprivation after controlling for potential confounding individual characteristics was also addressed. In order to answer this question, a similar model to hospitalisation was used to investigate whether deprivation explains mortality after controlling for a range of confounding variables. Deprivation is the main study factor and changes were examined based on the introduction of potential confounding variables. Two periods were compared; 1994–1999 and 2000–2005.

Similar to hospitalisation, the baseline model consisted of deprivation quintiles only. That model illustrated that there is a social gradient in alcohol-related mortality as there was a clear increase in IRRs as deprivation increased. For both periods, the most deprived quintiles have rates which are three times higher than the least deprived quintile. While the middle quintile (three) had the same rates for both periods, the rates in quintiles four and five increased, showing differences between deprived areas.

Table 5.11: Regression modelling for alcohol-related mortality 1994–1999

	Model 1				**Model 2**				**Model 3**				**Model 4**			
	NZ deprivation				**Gender/Age**				**Rural/urban**				**Ethnicity**			
	IRR	**LCI**	**UCI**	**p value**	**IRR**	**LCI**	**UCI**	**p value**	**IRR**	**LCI**	**UCI**	**p value**	**IRR**	**LCI**	**UCI**	**p value**
Quintile 1-least deprived	**1**				**1**				**1**				**1**			
Quintile 2	**1.52**	1.14	2.01	**0.00**	**1.49**	1.13	1.98	**0.01**	**1.50**	1.13	1.99	**0.01**	**1.46**	1.10	1.94	**0.01**
Quintile 3	**1.70**	1.30	2.24	**0.00**	**1.65**	1.26	2.17	**0.00**	**1.65**	1.25	2.16	**0.00**	**1.54**	1.17	2.03	**0.00**
Quintile 4	**1.96**	1.51	2.55	**0.00**	**1.94**	1.49	2.53	**0.00**	**1.91**	1.47	2.49	**0.00**	**1.70**	1.29	2.23	**0.00**
Quintile 5-most deprived	**2.73**	2.12	3.52	**0.00**	**3.18**	2.47	4.10	**0.00**	**3.14**	2.43	4.04	**0.00**	**2.30**	1.69	3.13	**0.00**
Gender																
Female					**1**				**1**				**1**			
Male					**3.34**	2.85	3.91	**0.00**	**3.35**	2.86	3.93	**0.00**	**3.34**	2.85	3.92	**0.00**
Age groups																
65+					**1**				**1**				**1**			
55–64					**0.76**	0.63	0.91	**0.00**	**0.76**	0.64	0.91	**0.00**	**0.75**	0.62	0.89	**0.00**
45–54					**0.41**	0.34	0.50	**0.00**	**0.41**	0.34	0.51	**0.00**	**0.40**	0.33	0.49	**0.00**
35–44					**0.19**	0.15	0.25	**0.00**	**0.19**	0.15	0.25	**0.00**	**0.19**	0.15	0.24	**0.00**
25–34					**0.08**	0.06	0.11	**0.00**	**0.08**	0.06	0.11	**0.00**	**0.08**	0.05	0.11	**0.00**
15–24					**0.06**	0.04	0.09	**0.00**	**0.06**	0.04	0.09	**0.00**	**0.06**	0.04	0.08	**0.00**
Urban/Rural																
Urban									1				1			
Rural									0.86	0.69	1.08	0.20	0.88	0.71	1.10	0.26
% European Ethnicity													**0.99**	0.99	1.00	**0.00**

LCI-Lower confidence interval

UCI-Upper confidence interval

Bold figures indicate statistically significant associations (p <0.05)

Table 5.12: Regression modelling for alcohol-related mortality 2000–2005

	Model 1				**Model 2**				**Model 3**				**Model 4**			
	NZ deprivation				**Gender/Age**				**Rural/urban**				**Ethnicity**			
	IRR	**LCI**	**UCI**	**p value**	**IRR**	**LCI**	**UCI**	**p value**	**IRR**	**LCI**	**UCI**	**p value**	**IRR**	**LCI**	**UCI**	**p value**
Quintile 1-least deprived	**1**				**1**				**1**				**1**			
Quintile 2	**1.58**	1.23	2.02	**0.00**	**1.55**	1.21	1.98	**0.00**	**1.55**	1.21	1.98	**0.00**	**1.55**	1.21	1.99	**0.00**
Quintile 3	**1.70**	1.34	2.17	**0.00**	**1.64**	1.29	2.09	**0.00**	**1.64**	1.28	2.08	**0.00**	**1.64**	1.29	2.10	**0.00**
Quintile 4	**2.35**	1.87	2.95	**0.00**	**2.29**	1.82	2.88	**0.00**	**2.28**	1.81	2.86	**0.00**	**2.29**	1.81	2.90	**0.00**
Quintile 5-most deprived	**2.97**	2.38	3.71	**0.00**	**3.49**	2.79	4.36	**0.00**	**3.47**	2.78	4.34	**0.00**	**3.54**	2.72	4.62	**0.00**
Gender																
Female					**1**				**1**				**1**			
Male					**2.85**	2.49	3.25	**0.00**	**2.85**	2.50	3.25	**0.00**	**2.85**	2.50	3.25	**0.00**
Age groups																
65+					**1**				**1**				**1**			
55–64					**0.60**	0.52	0.70	**0.00**	**0.60**	0.52	0.71	**0.00**	**0.61**	0.52	0.71	**0.00**
45–54					**0.38**	0.32	0.45	**0.00**	**0.38**	0.32	0.45	**0.00**	**0.38**	0.32	0.45	**0.00**
35–44					**0.11**	0.09	0.14	**0.00**	**0.11**	0.09	0.14	**0.00**	**0.11**	0.09	0.14	**0.00**
25–34					**0.04**	0.03	0.07	**0.00**	**0.04**	0.03	0.07	**0.00**	**0.04**	0.03	0.07	**0.00**
15–24					**0.02**	0.01	0.04	**0.00**	**0.02**	0.01	0.04	**0.00**	**0.02**	0.01	0.04	**0.00**
Urban/Rural																
Urban									1				1			
Rural									0.95	0.79	1.14	0.59	0.95	0.79	1.14	0.59
% European Ethnicity													1.00	1.00	1.00	0.79

LCI-Lower confidence interval

UCI-Upper confidence interval

Bold figures indicate statistically significant associations (p <0.05)

With the introduction of two control variables in gender and age, there was a slight increase in the most deprived and a decrease in the least deprived areas, showing that most age groups and genders mediate in the relationship between mortality and deprivation. For gender, however, males had a three times higher incidence of mortality than females in the first period. In the second period, the IRRs attenuated by 14%. Mortality rates between males and females decreased over time. For the age groups, the reference age was 65 and over as discussed earlier in Chapter 4. There were decreases in IRRs as age decreased, showing that the oldest age groups had higher rates than the younger age groups. This is not surprising since alcohol-related death from long-term diseases such as liver cirrhosis, takes a long time to develop. This result was consistent for both the periods.

When the data was adjusted for urban and rural location, the IRRs in the most deprived quintile reduced marginally, showing that location does not mediate in the association between deprivation and mortality. For both periods the IRRs for quintile five still remained three times higher than the reference group in quintile one (Model 3). It is interesting to note that the difference between urban and rural mortality was not significant for the two periods after controlling for deprivation, age, and gender. Temporal trends had earlier indicated that in some years rural rates were actually higher than urban mortality rates.

When the final control, ethnicity (percentage European), was added, the changes in the deprivation quintiles varied again (Model 4). In the first period, there was a reduction in quintile five from IRR 3.14 (CI = 2.43–4.04) at baseline, to IRR 2.3 (CI = 1.69–3.13) after adjusting for ethnicity. This reduction however was not statistically significant because of overlapping confidence intervals. For the second period, the rates were fairly stable with a slight increase. The first period's result can be attributed to the year 1994 and 1995 where data for ethnicity was not recorded. While there are no differences in the other quintiles the results indicate that majority of people who die from alcohol-related consumption are from minority ethnic groups residing in the most deprived quintile for both periods. For gender, age, and urban and rural location, the IRRs were fairly stable during both periods even when after adjusting for ethnicity.

The regression results show that deprivation explains the differences observed in alcohol-related mortality. People living in the most deprived areas have higher rates than those living in least deprived areas, even after adjusting for confounding variables. The difference between quintile one and five increased slightly, raising further questions as to whether contextual factors were responsible for the differences. During the first period, there is a significant interaction between ethnicity and deprivation, because of a substantial reduction in the IRRs of quintile five when the ethnicity variable was introduced. This change can be attributed to missing ethnicity data for the first two years of the first period. For age, it is obvious that the highest rates were in the age group 65+. The rates for urban and rural areas remained constant throughout both periods, though they were not statistically significant. Two results stand out, people residing in quintile five have higher IRRs of mortality than those in other quintiles, and there is a reduction in IRRs between males and females over time.

5.7 Summary

Alcohol-related mortality has presented some interesting findings. First alcohol-related mortality is more of a problem among those aged 65 and over, since alcohol-related diseases take a long time to develop and to cause death. This pattern is the same for both males and females with the highest rates in the age group 65 and over. Secondly, male rates are considerably higher and contribute disproportionately to the overall rates; however, there has been a slight reduction in the difference over time. Thirdly, Māori rates were two times higher than those for non-Māori. Fourthly, the rates are higher in urban areas compared to rural areas, although the rural male rates are increasing and even surpassed urban males in later years. However, caution must be taken while interpreting the urban-rural differences because of higher confidence intervals. Lastly, those living in the most deprived areas are more likely to die than those in the least deprived areas. After controlling for a range of confounding variables the most deprived areas were found to have higher rates of mortality than the least deprived, suggesting that contextual factors may be important in explaining mortality.

While this analysis has been mostly descriptive, the results provide a basis for further analysis to better understand the causes of the high rates of mortality in the most deprived areas. Detailing the demographic, spatial and temporal variations of mortality could be a basis for further research to better understand the causes. This thesis sets out to develop an understanding of the contextual factors that contribute to alcohol consumption and subsequent health outcomes, including mortality, since the trends are as a result of hazardous consumption. Research has established that there are contextual factors in deprived areas that facilitate consumption, but there is a dearth of studies that examine ‘place’ effects, particularly access to alcohol outlets.

5.8 How do the two proxies compare?

This section compares the results between hospitalisation and mortality to identify which one qualifies as a good proxy. A good proxy will be defined based on the literature review which illustrated that most hazardous consumers have certain characteristics. They are young (15-24) and mostly males, however, female rates amongst the young (15-24) are rising, people living in most deprived areas and members of a minority ethnic group.

Table 5.13: Comparison between hospitalisation and mortality as proxies of consumption

Socio-demographics	**Hospitalisation**	**Mortality**
Age	Younger age group 15–24	Older age group 65+
Gender	Higher male rates and increasing female rates but the gap reduced significantly over the years.	Higher male rates and increasing female rates over the years - gap reduced marginally.
Ethnicity	Higher rates in Māori. Male and female Māori rates also higher.	Higher rates in Māori. Male Māori rates higher but no difference in Māori females.
Urban/rural	Urban rates higher than rural throughout the years.	Urban rates higher than rural rates, but some years the opposite occurred.
Deprivation	Higher rates in lower SES.	Higher rates in lower SES.

Initially, table 5.13 compares and contrasts the key findings for each of the proxies. The pattern of mortality and hospitalisation is completely reversed with age. More young people were hospitalised for alcohol related problems while more older people aged 65 and over were more likely to die from alcohol related disease. The chronic illnesses take a longer time to develop thus killing older people. Overall, the result shows that more young people were hospitalised while the older age groups were more likely to die from alcohol-related disease.

Similar to other studies on alcohol, hospitalisation and mortality standardised rates are higher for males than females. However, female rates have recently increased resulting in a narrowing of the gender gaps, especially in hospitalisation. The standardised rates between the two genders remained high in mortality. Most interesting, however, is that crude rates (Table 5.9) for pancreatitis were higher in females than in males for alcohol-related mortality. It is important to note that hazardous consumption and heavy episodic drinking among females are recent phenomena and despite the decrease in gender differences in standardised hospitalisation rates, mortality from alcohol consumption is a slow process and therefore it will take a while before high numbers of deaths are registered for females.

There are only two demographic variables that are consistent in both mortality and hospitalisation and these are ethnicity and SES (shaded in Table 5.13). Starting with ethnicity, the study has shown that the standardised rates for Māori compared to non-Māori were consistently two times or more high in both mortality and hospitalisation. Similarly, the people living in the most deprived areas had higher hospitalisation and mortality rates than least deprived groups. The standardised rates were consistently higher in most deprived quintiles and increased within the two periods in both regression analyses as well as in the age standardised rates.

Alcohol-related hospitalisation was a problem of urban areas. In terms of gender, urban admission standardised rates were high for both males and females. For mortality, however, there was a slight difference with the rates for males reducing between the two periods. In some years, the rural male mortality rates were higher than the urban male rates.

Both hospitalisation and mortality were used in this analysis as proxies for consumption. Based on the literature reviewed in Chapters 2 and 3, the results from this analysis show that hospitalisation seems to be a better proxy for consumption. Hospitalisation results are consistent with the literature which shows that young people below the age of 25, of low socio-economic status, are more likely to be hazardous consumers. These results showed that the differences between alcohol-related hospitalisation rates of males and females have reduced over time, illustrating increasing rates amongst the younger females aged 15-24. Minority ethnic groups were also more likely to be hospitalised. The results for hospitalisation are also consistent with the New Zealand Health Survey, which shows that typical hazardous consumers are: young (under 25 years of age); less affluent; more likely to be male, although with increases in female hazardous drinking rates; and more likely to be of Māori or Pacific Island ethnicity. In conclusion, this summary points to hospitalisation as the best proxy. The analyses have also indicated the importance of understanding the 'place' effects of low SES areas on the people living in them, and how contextual factors within low SES areas contribute to hospitalisation and mortality, since SES was consistently a factor in both proxies.

5.9 Chapter Conclusion

The results show alcohol-related admission and mortality rates are influenced by age, gender, ethnicity, urban/rural location, deprivation and geography. First, the analysis of the mortality rates showed that the oldest age group (65 and over) is the most likely age group to die from alcohol-related disease. Conversely for hospitalisation, it is the younger age groups who are most likely to be admitted to hospitals. The differences also varied by year with high confidence intervals. Secondly, more males than females were affected by alcohol-related disease. However, the younger females (aged under 25) had the highest growth rates in hospitalisation over the years and soon there will be a convergence with the men of similar ages. Thirdly, the results indicated that Māori rates were two times higher than non-Māori rates for both mortality and hospitalisation. Mortality rates between Maori and non-Maori females were not significantly different. Fourthly, after controlling for a range of 'place' and individual variables, those in the most deprived areas were three times more likely to be admitted or die from alcohol-related disease than those in the least deprived areas. Many studies have suggested that deprivation is a proxy for other determinants of health-related behaviour in the most deprived quintiles (Macintyre et al., 2002). It is therefore not surprising that people living in deprived areas were the group most likely to be hospitalised, the predominant inhabitants of these areas are minority ethnic groups. Fifth, the results show that alcohol-related hospitalisations are more of an urban problem, but when it comes to mortality, the rural rates have risen and even surpassed the urban rate for males, however, the rural rates for hospitalisation and all mortality rates had high confidence intervals, indicating no statistical significance. This trend is consistent with the literature in studies conducted in other contexts, however, the rise in male rural mortality rates despite having overlapping confidence intervals appears to be a New Zealand phenomenon and therefore more exploratory studies need to be undertaken to understand this trend.

Whilst the hospitalisation and mortality rates were used as proxies for consumption, Rehm et al., (2003) argue that special focus should be given to the volume of alcohol consumed, as well as heavy episodic drinking, as both are important in the prevention of harm, especially at the population level. Investigating how consumption is influenced by contextual factors will lead to even better prevention strategies. There is a need to understand why the most deprived areas have higher rates than the least deprived and why these are increasing. The next chapter examines the potential 'place effects' by investigating the influence of ready access to alcohol outlets. Of specific interest is the geographic distribution of these outlets and the relationships between their distribution and deprivation patterns in New Zealand but stratified by urban/rural locations and regions.

Chapter 6 Access to alcohol outlets

6.1 Introduction

There is no doubt that hazardous alcohol consumption is linked to multiple health problems. Chapter 5 investigated two proxies of alcohol consumption and found that that rates of alcohol-related hospitalisation and mortality increased in the most deprived areas compared to other areas, even after controlling for individual factors. Deprivation was identified as the driving force; however, the evidence is inconclusive about other causes of hospitalisation and mortality, especially with the recognition that deprivation is a proxy measure for other area effects (Macintyre et al., 2002). Therefore, it would be prudent to have direct measures of what are the physical and social constraints in these deprived neighbourhoods. This chapter examines reasons why people living in deprived areas have poorer alcohol-related health outcomes; since there is no doubt that such outcomes are the results of excess alcohol consumption.

There is a hypothesis that neighbourhood characteristics augment excessive alcohol consumption patterns over and above individual factors (Blomgren et al., 2004). These neighbourhood factors include community resources, which can have both a positive and negative influence upon health. Studies show that the positive resources available to individuals within their neighbourhoods can make life better (French and Jeffery, 2001). Such resources may include: parks for exercise and relaxation, quality schools providing good education (Marmot, 2005), and fruit and vegetable shops for good nutrition (Zenk et al., 2005). On the other hand neighbourhood resources, such as liquor stores, smoking areas and drug selling areas have negative influences (Bernard et al., 2007). For purposes of this study, the 'negative' community resource is the ease of access to alcohol outlets, such as access to bars hotels, taverns, liquor stores and supermarkets. Thus in order to understand the rates of hospitalisation and mortality observed in chapter five, there is a need to understand whether ease of access contributes to excess alcohol consumption.

This chapter addresses the third objective of the thesis which is to develop and test measures of access to alcohol outlets for small areas. With this in mind, four particular questions are addressed:

- Is there a relationship between access to alcohol outlets and deprivation in small areas in New Zealand?
- Is there a relationship between the density of alcohol outlets and deprivation?
- Does the relationship between access to alcohol outlets and deprivation vary by urban/rural location?
- Does the relationship between access to alcohol outlets and deprivation vary within the 16 administrative regions in New Zealand?

To answer these questions this chapter examines the various alcohol outlet access measures (density and distance) with specific interest in the geographic distribution of alcohol outlets and explores their relationship with deprivation in urban and rural communities, both regionally and across the whole of New Zealand. Initially an analysis will be undertaken for the whole of New Zealand and then repeated for urban/rural locations and lastly the 16 administrative regions.

6.2 National differences

6.2.1 Number/density of outlets by deprivation

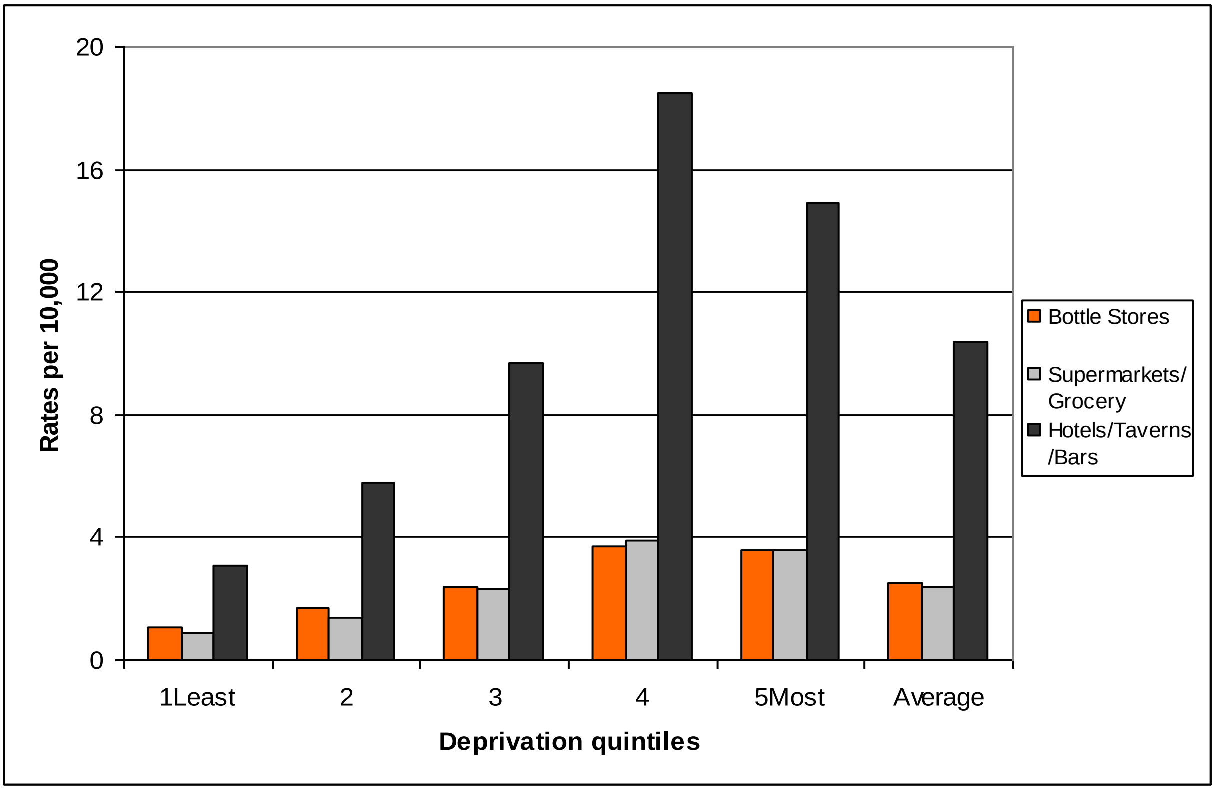
Table 6.1 shows the total crude count of alcohol outlets by deprivation. This indicates that there are more alcohol outlets in the two most deprived quintiles compared to the least deprived quintiles. The total numbers show that there are more outlets of each category in the most deprived areas (quintiles four and five) than in the least deprived (quintile one).

Table 6.1: Count of alcohol outlets by category and type in New Zealand

	Deprivation Quintiles					
Category	**1 Least deprived**	**2**	**3**	**4**	**5 Most deprived**	**Total row**
Bottle Stores	94	135	188	293	290	**1 000**
Hotel/Taverns/Bars	255	471	774	1 462	1 187	**4 149**
Supermarkets and general stores/dairies	72	111	181	306	289	**959**
Type						
Off-licence (defined as alcohol outlets where alcohol is bought and taken away)	239	399	588	1 002	906	**3 134**
On-licence (alcohol is consumed within the premises)	182	318	555	1 059	860	**2 974**
Total	**421**	**717**	**1 143**	**2 061**	**1 766**	**6 108**

Figure 6.1 shows that there is a steep social gradient and for every increase in deprivation, there is a corresponding increase in number of alcohol outlets. The most deprived quintiles, (quintiles 4 and 5) are the only quintiles that have rates of alcohol outlets above the New Zealand average of 10 per 10 000. By comparison, quintile one (least deprived) has three outlets per 10 000 population. This gradient shows that there are five times more outlets per 100 000 population in the most deprived areas when compared to the least deprived.

Figure 6.1: Category of alcohol outlets per 10 000 population in New Zealand



Further analysis was undertaken to establish the relative difference in the density of outlets between Q1 and Q5, stratified by category of alcohol outlets (Table 6.2). Table 6.2 shows that the difference in the number of outlets in the most deprived and least deprived areas varies by category of outlet. There are more outlets by category in the most deprived compared to the least deprived quintiles. There are five times more supermarkets, four times more hotels, taverns, bars and clubs, and three times more bottle stores in the most deprived areas compared to the last deprived, showing differences in relative inequality.

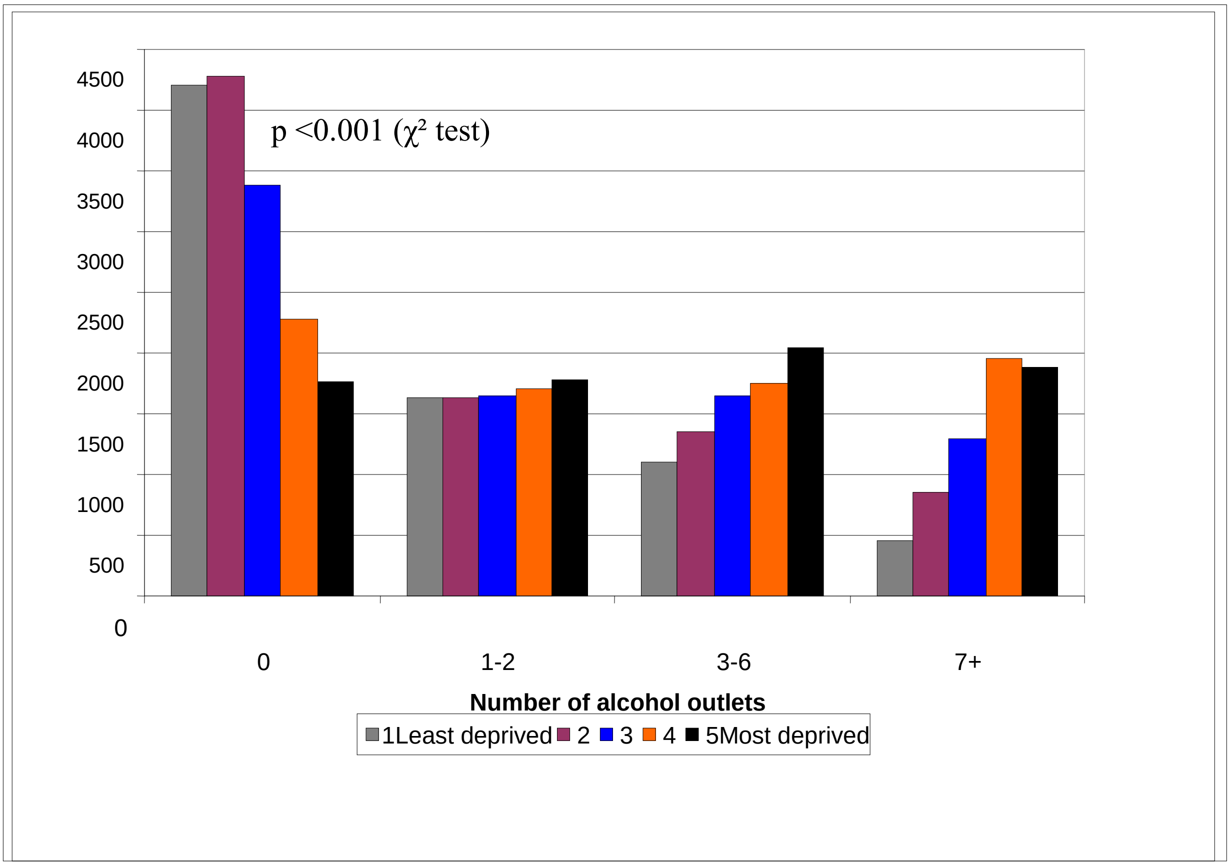
Table 6.2: Alcohol outlets per 10 000 population in New Zealand: ratios and correlations

Category of alcohol outlets	Total Number	Quintile 1 Least deprived	Quintile 5 Most deprived	**Ratio Quintile 5:1**
Bottle stores	1 000	1.1	3.6	**3.2**
Supermarket and General stores/dairies	959	0.9	3.6	**4.8**
Hotel, Tavern, Bars	4 149	3.1	14.9	**4.0**
Total	**6 108**	**5.1**	**22.1**	**4.2**

6.2.2 Density of outlets (Buffers of 800 and 3000 metres)

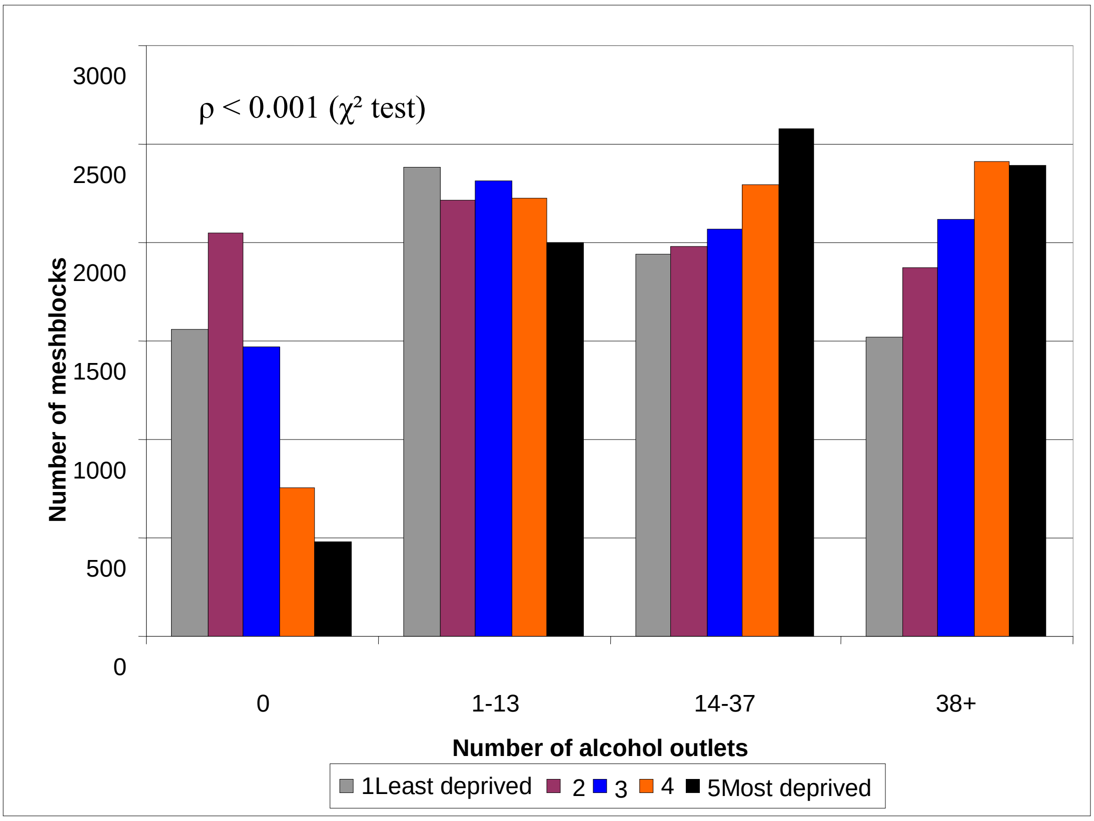
The initial results focussed on the number and rate of outlets located within the meshblock, stratified by deprivation. The next step is to determine the effect of differences in density within a walking distance of 800 metres (Figure 6.2). The meshblocks are divided into four categories; those with no outlet: those with 1–2 outlets: those with 3–6 outlets: and those with more than seven outlets. There are differences in density between the most deprived and the least deprived meshblocks. The most deprived have fewer meshblocks without an outlet compared to the least deprived. The number of meshblocks without an outlet is three times more in the least deprived areas (n=4200) compared to the most deprived (n=1759). For meshblocks with only 1–2 outlets the numbers are fairly consistent among all the deprivation groups. For more than three outlets, the numbers are reversed, when compared to no outlets, and there are more meshblocks in most deprived areas than least deprived. For example, in meshblocks with seven or more outlets within the 800 metres buffer, there are three times more outlets in the most deprived areas (n=1884) compared to the least deprived (n=459), this pattern shows that those in the most deprived neighbourhoods have a wider choice of alcohol outlets to walk to (Figure 6.2). These results show that the proportions of meshblocks in the most deprived areas with an alcohol outlet within a walking distance are higher than in the least deprived areas. This result was statistically significant ($p < 0.001$).

Figure 6.2: Alcohol outlets within 800 metres walking distance (buffer) by meshblocks and deprivation, in New Zealand



The analysis for a 3000 metre driving distance buffer produced similar results to the 800 metre walking distance; as deprivation reduces so proximity to alcohol outlets decreases (Figure 6.3). There are 1557 meshblocks with no outlets within driving distance for the least deprived areas, compared to only 484 meshblocks for the most deprived, a threefold difference. Conversely, as deprivation increases, the numbers of meshblocks with outlets within the 3000 metre buffer increases and the results are statistically significant ($p < 0.001$). There is an association between deprivation and the number of outlets in the 3000 metres buffer. In the most deprived areas there are 2394 meshblocks which have access to more than 38 outlets, while for the least deprived there are only 1519 meshblocks with this level of choice. It is interesting to note that the difference between deprivation quintiles in meshblocks with 1–13 alcohol outlets within driving distance is minimal. Larger differences are observed at either the lowest or highest numbers of outlets per meshblock.

Figure 6.3: Alcohol outlets within 3000 metres driving distance (buffer) by meshblocks and deprivation in New Zealand



6.2.3 Distance to alcohol outlets

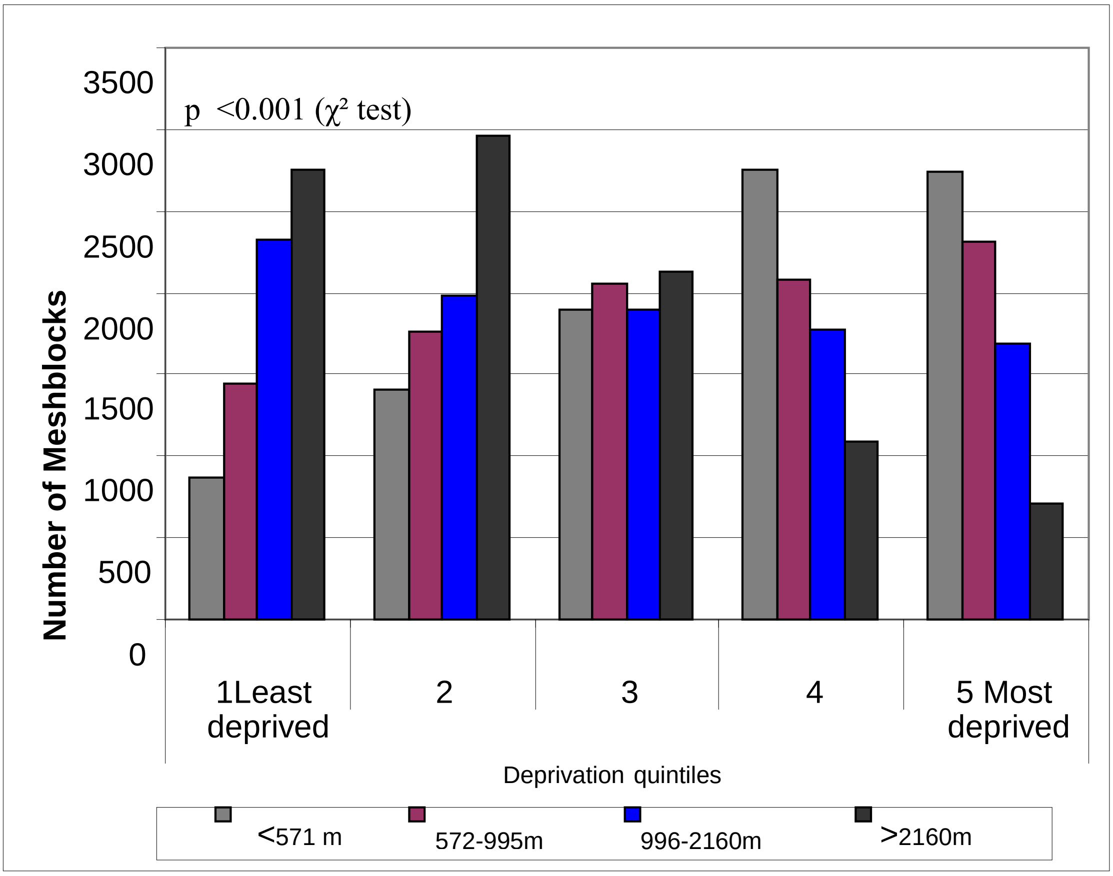
The previous results show that there are more outlets in deprived areas as well as more neighbourhoods with outlets within walking distance. The next step is to determine the least cost distance to outlets. The distances within the most deprived areas are shorter for all categories and types of outlet when compared to the least deprived. Table 6.3 shows that the median distance to any alcohol outlet varies by deprivation. The median distance in the least deprived areas to alcohol outlets is 1537 metres, whereas in the most deprived areas the median distance is only 727 metres. The ratio shows that the distance in the least deprived areas is twice that of the most deprived. Similar results were observed when types of alcohol outlet were examined, with the ratios varying from two to 2.5. For off-licence outlets those living in the least deprived areas have to cover almost a distance 2.5 times more than the most deprived. The results show that alcohol outlets are within easier reach in the most deprived neighbourhoods when compared to the least deprived.

Table 6.3: Median distance in metres to alcohol outlets in New Zealand

	Deprivation Quintiles					
	1 Least deprived	**2**	**3**	**4**	**5 Most deprived**	**Ratio Q1:Q5**
All alcohol outlets	1 537	1 343	1 020	776	727	**2.11**
On license	1 455	1 277	994	783	735	**1.98**
Off License	1 722	1 532	1 103	756	696	**2.47**

The distance to alcohol outlets varied from about 10 metres to about 19 000 metres. Median distance was stratified into four quartiles of approximately 9660 meshblocks each. These quartile categories are <571 metres (closest), 572–995 metres (closer), 996–2160 metres (further) and over 2160 metres (furthest). There is a social gradient, with the shortest or closest distances located in the most deprived neighbourhoods. In the least deprived areas, the distances are longer compared to the most deprived. There are approximately 867 meshblocks with a distance of less than 571 metres in the least deprived areas compared to 2739 meshblocks for the most deprived. Conversely, for the greatest distance, which is slightly over 2km, there are 710 meshblocks in the most deprived areas compared to 2759 meshblocks in the least deprived. The people in the most deprived categories have to cover a comparatively shorter distance to alcohol outlets compared to the people in the least deprived areas, thereby showing that the most deprived have better access to alcohol outlets. The chi-square test for the association between the distance to alcohol outlets and deprivation is statistically significant ($p < 0.001$).

Figure 6.4: Distance to alcohol outlets by meshblocks and deprivation in New Zealand



6.3 Summary

The analysis for the whole of New Zealand shows that there is a social gradient with increasing number of outlets as area deprivation increases. These results are consistent even when the total population is taken into account by calculating the rates of outlets per 10 000 population. When buffers are created there is better access in the most deprived areas and poorer access in the least deprived. Using buffers for walking and driving distances is important in showing the catchment area for people living within a meshblock rather than restricting the measures to linear distance only. Travel distances were shorter in the most deprived catchment areas, showing greater ease of access to alcohol in these areas. Other studies have shown similar results with the most deprived neighbourhoods having shorter distances to alcohol outlets (Huckle et al., 2008). A summary of results shows that all measures (rates of outlets per 10 000, walking and driving distance catchments and least cost distances) have a relationship with deprivation.

To establish the relevance of these results for larger areas they were stratified at both urban/rural and regional level. The next section presents the results for both urban and rural areas and also for the different regions in New Zealand.

6.4 Urban/ rural differences in access

6.4.1 Number/density of outlets by deprivation

There are variations in number, type and category of outlets within each of the deprivation quintiles stratified by urban and rural location. Urban and rural classifications were derived from the census and the differences between them were examined by calculating the rates of alcohol outlets per 10 000 population. There is a social gradient with increases in deprivation accompanied by increases in the number of outlets per 10 000 population (Figures 6.5 and 6.6). This gradient is similar for both urban and rural areas and similar to the national patterns examined earlier.

There are more alcohol outlets per person in the rural areas than in the urban areas. The urban average is 14 per 10 000, the rural average is 24 per 10 000. This pattern can be attributed to the low numbers of people living in rural areas.

Figure 6.5:Urban rates by category of alcohol outlets per 10 000 population in New Zealand

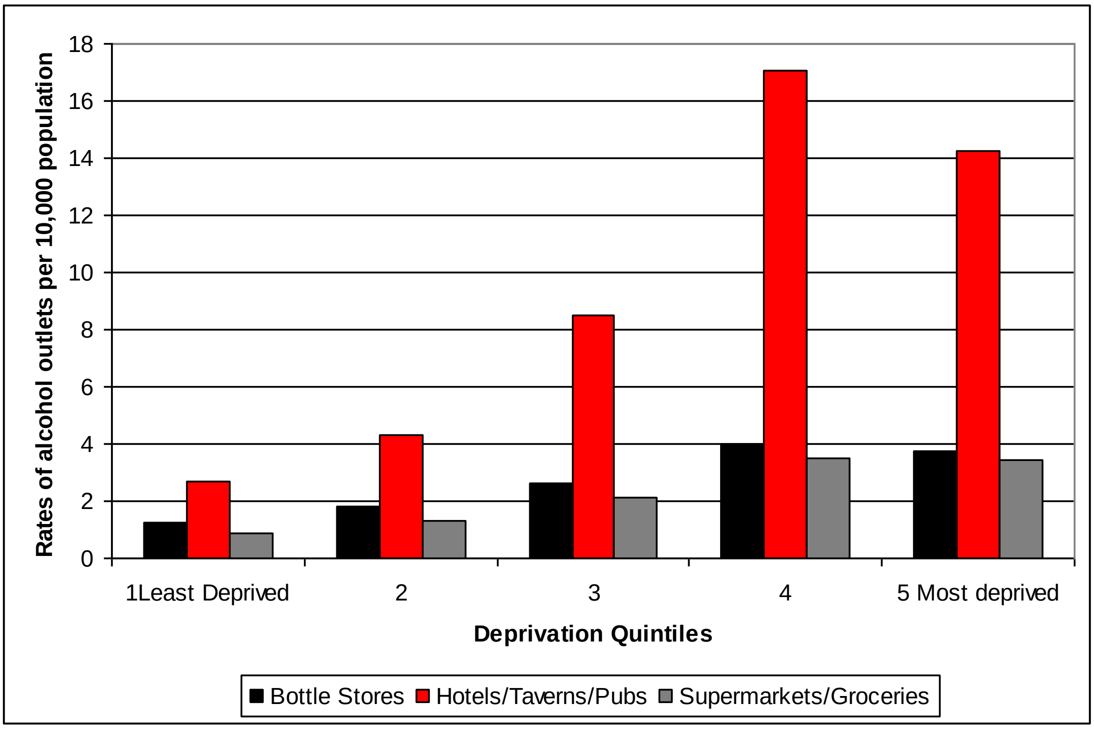
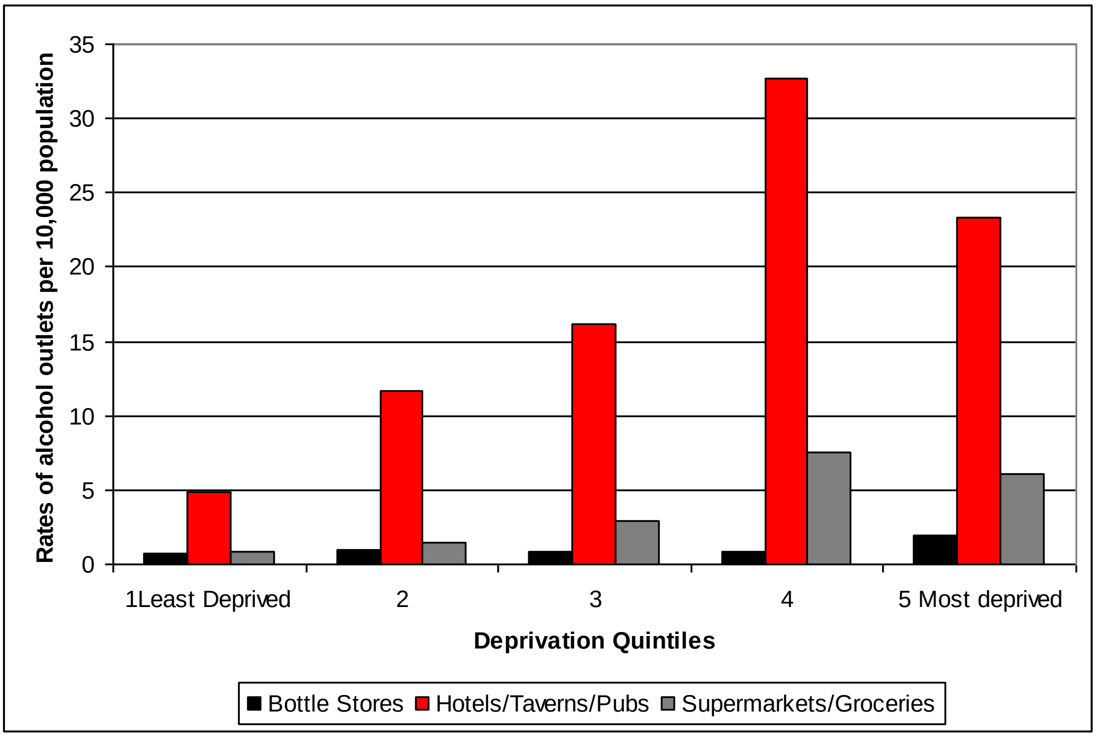


Figure 6.6: Rural rates by category of alcohol outlets per 10 000 population in New Zealand



An examination by ratios of this relationship between deprivation and number of outlets found that all the rate ratios for both urban and rural were above one, showing that there were differences between the two areas. There were more outlets per 10 000 population in the most deprived areas compared to the least deprived in both urban and rural areas. The ratios for both urban and rural illustrate that there are about five times more outlets in the most deprived quintiles compared to least deprived. Table 6.4 illustrates the ratio difference between the categories of outlets which range from 3.1 to 5.3 in urban areas and 2.7 to 7.0 in rural areas.

Table 6.4: Alcohol outlet rates per 10 000 population for New Zealand by urban and rural areas in meshblocks divided into deprivation quintiles

			Deprivation Quintiles					
		N	**1 Least Deprived**	**2**	**3**	**4**	**5 Most deprived**	**Ratios Q5/Q1**
Urban	All alcohol outlets	5 070	4.8	7.5	13.3	24.5	21.5	4.5
	Bottle Stores	946	1.2	1.8	2.6	4.0	3.8	3.1
	Hotels, taverns, bars	3 325	2.7	4.3	8.5	17.1	14.3	5.3
	Supermarkets, general stores/dairies	799	0.9	1.3	2.1	3.5	3.4	3.9
Rural	All alcohol outlets	1 038	6.5	14.1	20.0	41.0	31.2	4.8
	Bottle Stores	54	0.7	1.0	0.9	0.8	1.9	2.7
	Hotels, taverns, bars	824	4.9	11.6	16.2	32.7	23.3	4.8
	Supermarkets, general stores/dairies	160	0.9	1.5	2.9	7.5	6.1	7.0

6.4.2 Density of outlets (Buffers of 800 and 3000 metres)

The previous section showed that those within walking distance (buffer of 800 metres) in deprived area meshblocks have a wider choice of alcohol outlets**.** The buffer analysis was therefore analysed by both rural and urban categories. The urban analysis (Figure 6.7) shows a similar pattern to the national one, where there are more neighbourhoods with at least one outlet. The most deprived meshblocks have a larger proportion of two or more outlets than the least deprived, which have a larger share of meshblocks without any outlet. For example, for the 3–6 outlet category, there are more meshblocks within most deprived neighbourhoods (n=1950) than the least deprived (n=1100). People living in most deprived meshblocks have better access to a range of alcohol retail outlets in the urban areas. In the rural areas, the relationship between meshblocks with outlets within walking distance varied (Figure 6.8). The most deprived areas have many meshblocks with 1–6 outlets within walking distance when compared to the least deprived. The least deprived quintiles had many more meshblocks that were either without an outlet or had seven or more outlets when compared to the most deprived quintiles. The differences between urban and rural areas are clear. In rural areas 87% of meshblocks lacked an outlet compared to only 27% for the urban areas. The other 13% of the meshblocks in rural areas have outlets ranging from one to about 20 (Figure 6.8). It is certain that people living in rural areas have less choice, but the most deprived have more outlets to choose from than the least deprived within both walking and driving distance. The choice for alcohol outlets in rural areas is therefore limited compared to their urban counterparts. The pattern for the 800 metres walking distance buffer in urban areas is consistent for the whole of New Zealand.

Figure 6.7: Alcohol outlets within 800 metres walking distance (buffer) in urban meshblocks by deprivation quintiles in New Zealand

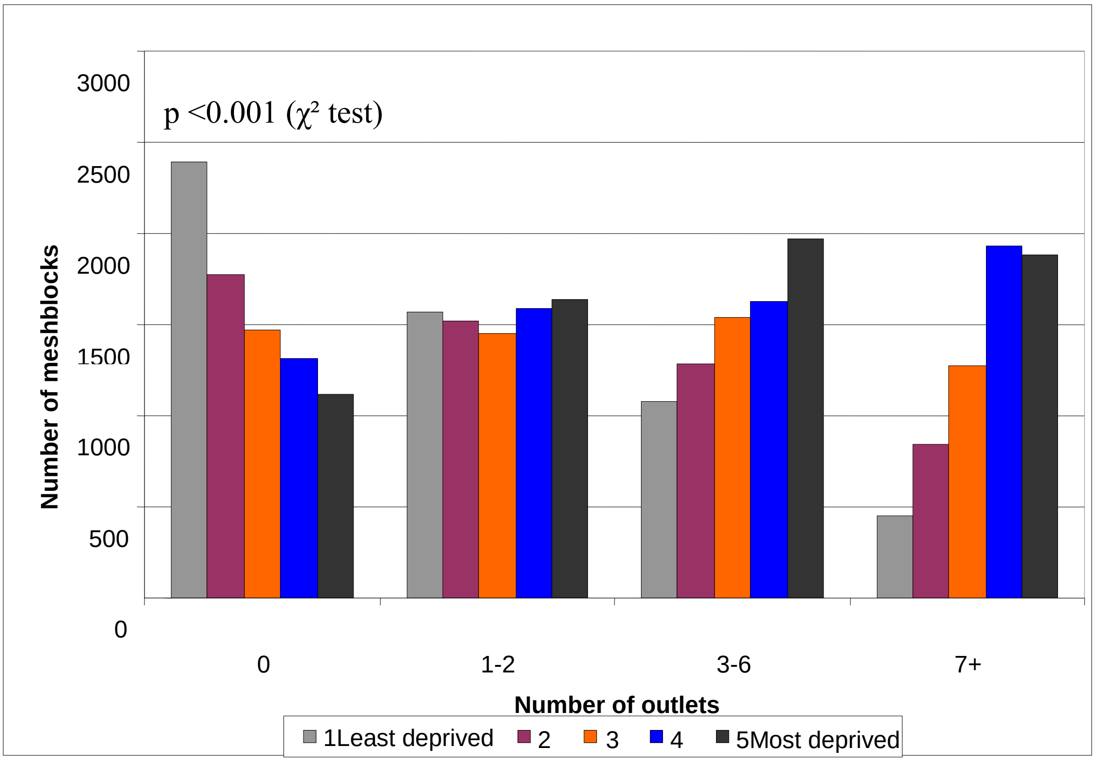


Figure 6.8: Alcohol outlets within 800 metres walking distance (buffer) in rural meshblocks by deprivation quintiles in New Zealand (Logarithmic scale)

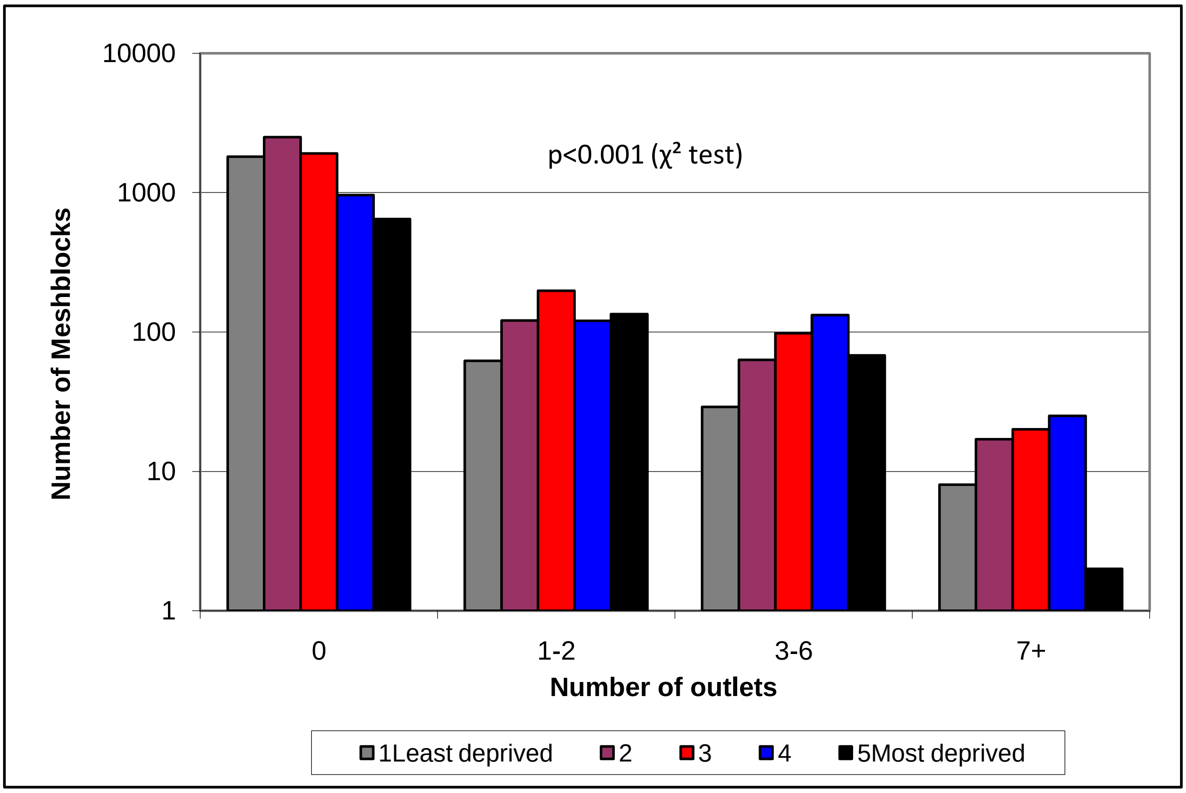
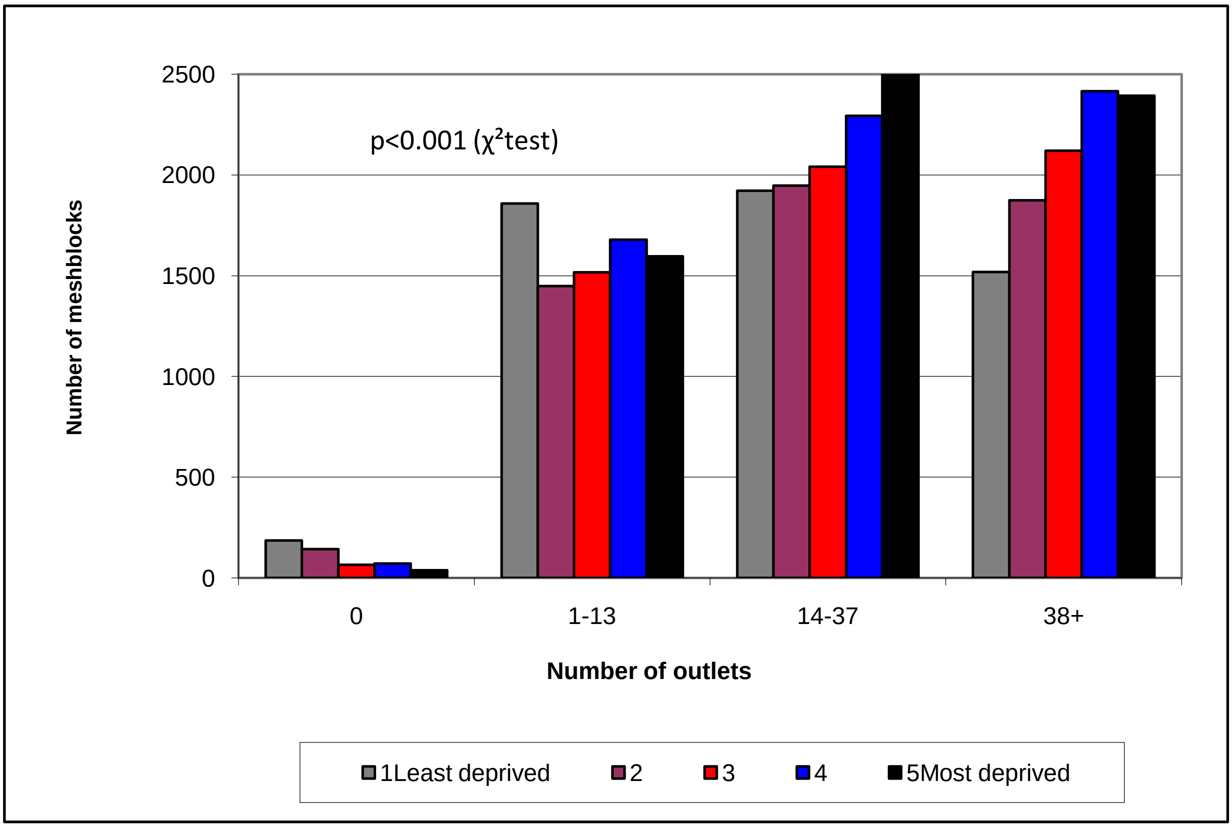
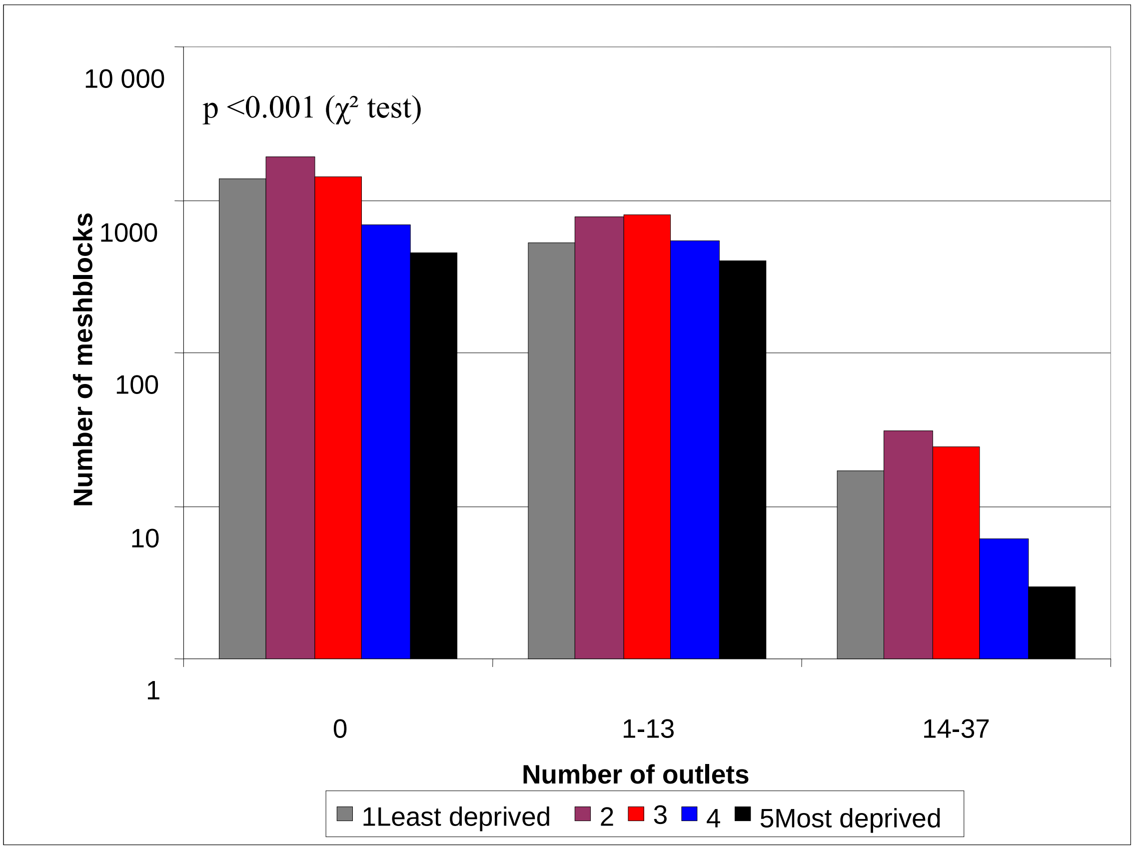


Figure 6.9: Alcohol outlets within 3000 metres driving distance (buffer) in urban meshblocks by deprivation quintiles in New Zealand



The 3000 metres driving distance buffer captures more outlets and translates into more meshblocks that are within driving distance of an alcohol retail outlet. There are more meshblocks within driving distance in the most, rather than the least, deprived areas. In the most deprived quintiles in urban areas there are 4970 meshblocks with 14 or more outlets within driving distance compared to only 3441 in least deprived (Figure 6.9). Neighbourhoods with 14 or more outlets in urban areas exhibit similar patterns to the whole of New Zealand. Almost 98% of neighbourhoods with no outlets within driving distance are located in rural areas (Figure 6.10). Rural areas in New Zealand are mostly farmland and people have to travel relatively longer distances for service.

Figure 6.10: Alcohol outlets within 3000 metres driving distance (buffer) in rural meshblocks, divided by deprivation quintiles in New Zealand (Logarithmic scale)

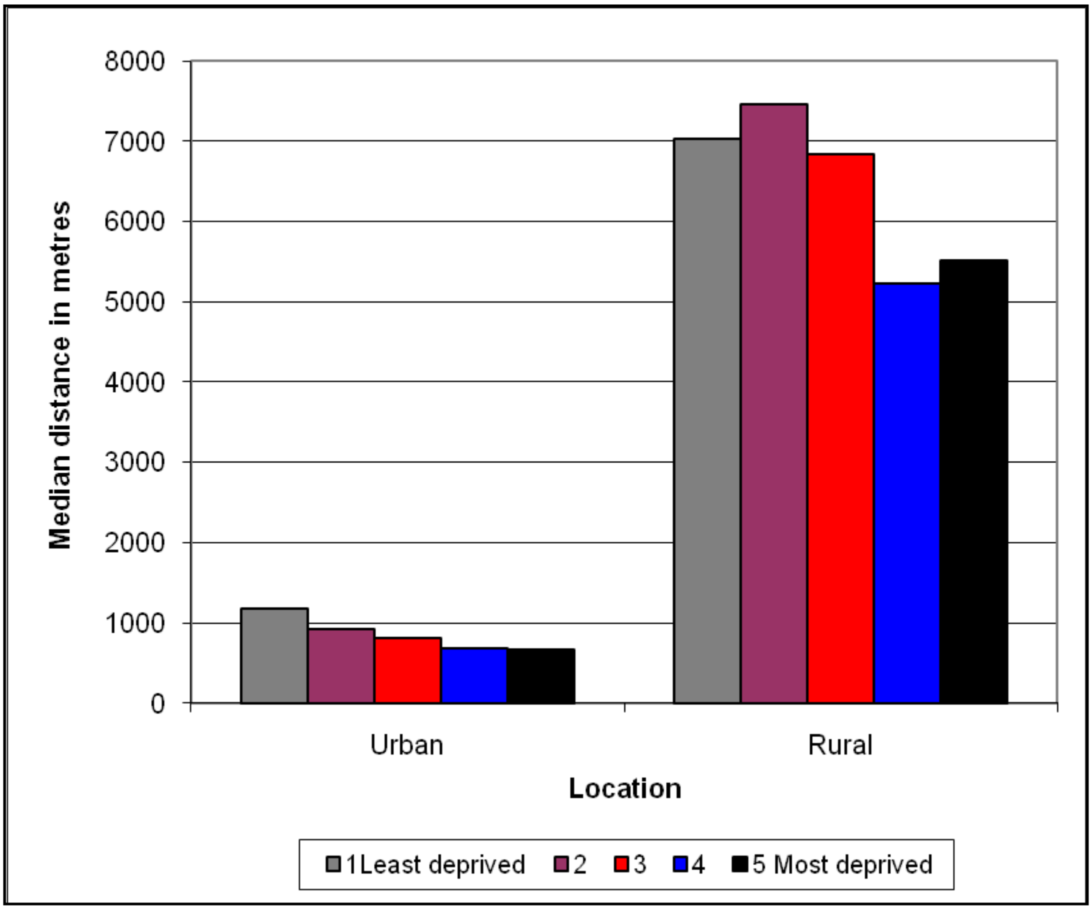


6.4.3 Distance to alcohol outlets

There are differences between overall median distance in rural areas and urban areas. The rural dweller has to travel longer distances than the urban dweller. A person living in an urban area has to travel 814 metres on average to get to an outlet, compared to 6.5

kilometres on average for someone living in a rural area, indicating that access to an alcohol retail outlet is eight times closer for those in urban areas. Despite the differences between urban and rural areas, an interesting result is observed when median distance is examined in deprivation quintiles (Figure 6.11). In urban areas, median distance shows a consistent relationship with deprivation, where increased levels of deprivation resulted in a decrease in median distance similar to what was observed nationally. In rural areas those living in the two most deprived quintile areas travel shorter distances to an alcohol outlet than those living in more affluent areas, the longest travel distance is in the second quintile. On average, the median distance in urban neighbourhoods is 1.1 kilometres in the least deprived quintile compared to 680 metres for those in the most deprived quintile.

Figure 6.11: Median distance in metres to alcohol outlets by deprivation quintiles and urban/rural classification in New Zealand



6.4.4 Urban/rural differences using the seven census categories

The previous analysis focussed on the two location categories of urban and rural. Further analysis was therefore undertaken for the seven categories of urban and rural using the census classification. As illustrated in Chapter 4, Statistics New Zealand provided a classification of urban and rural areas, and these are divided into seven categories including the main urban areas, satellite urban areas, and independent urban areas, rural remote areas, and rural areas with low, moderate or and high urban influence.

Counts and ratios of alcohol outlets indicated stark differences within the seven categories. There are 41 times more hotels, clubs, bars, and taverns in the most deprived areas compared to least deprived in the satellite urban areas. The difference between number of outlets in most and least deprived quintiles is not as large in the main urban and independent urban areas, which have five and eight times difference respectively. The results show that urban areas generally have more outlets in most deprived quintiles (Appendix 12).

As expected the rural areas have fewer alcohol outlets compared to urban areas. The least deprived rural areas with high urban influence have more alcohol outlets than the most deprived. The numbers of outlets in rural areas with moderate urban influence were the same in both the least and most deprived quintiles. There were more bottle stores in the least deprived parts of rural areas with low urban influence. In addition, there are 18 times more supermarkets and general stores/dairies in the most deprived areas compared to the least deprived. In highly remote rural areas, increased deprivation showed a corresponding increase in alcohol outlets.

When examining and comparing both urban and rural areas, the patterns in New Zealand's urban areas are reasonably consistent showing that the most deprived areas have higher numbers of alcohol outlets. Amongst rural areas, only those that are highly remote or have low urban influence that show patterns almost similar to what was observed in the urban areas and in New Zealand generally. Probably the reason why rural areas with high urban influence have a reverse pattern is because the 2006 census shows that most affluent people live in those rural areas surrounding cities.

The differences were manifested when the median distance to an alcohol outlet were calculated for all the seven urban/rural categories. Figure 6.12 shows that there were differences between urban and rural areas in median distance to alcohol outlets. The median distances in urban areas were shorter than for the rural areas. For all of the urban areas the figures are fairly consistent at median distance of about 800 metres. The rural areas had a much wider range, from about five kilometres in the rural with high urban influence, to about nine kilometres in the highly remote areas.

Figure 6.12: Median distance in metres to alcohol outlets by urban/rural location in New Zealand

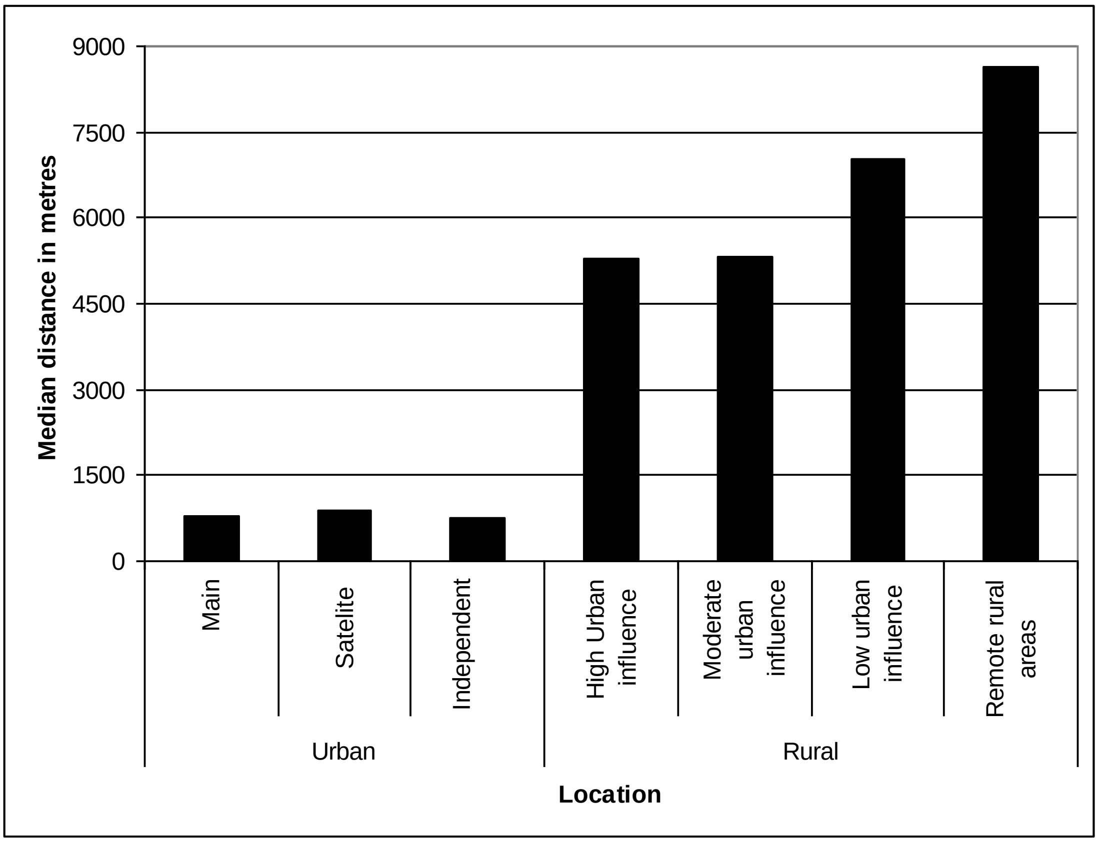
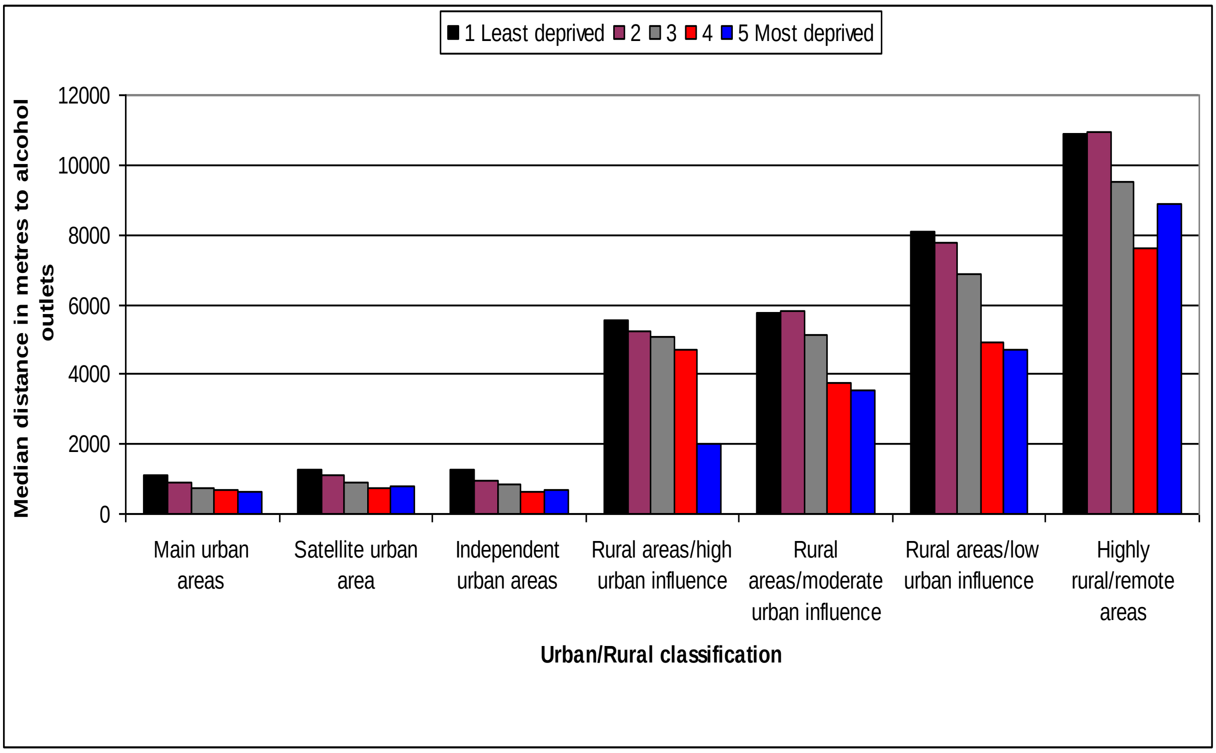


Figure 6.13 shows the variation for median distance in deprived areas for the seven categories of urban and rural. For all the different deprivation categories the most deprived had the shortest distance to travel, while the least deprived travelled relatively longer distances, except in highly rural remote areas. In rural areas with a high urban influence, there is a difference of almost two kilometres between the shortest median distance and the next shortest which is in quintiles four and five (most deprived). This is because, as mentioned earlier, affluent people tend to live in such areas (Census 2006) and probably resist the location of outlets in their locality.

Figure 6.13: Median distance in metres to alcohol outlets divided by deprivation quintiles and urban/rural seven category classification in New Zealand



6.5 Regional differences

6.5.1 Number/density of outlets by deprivation

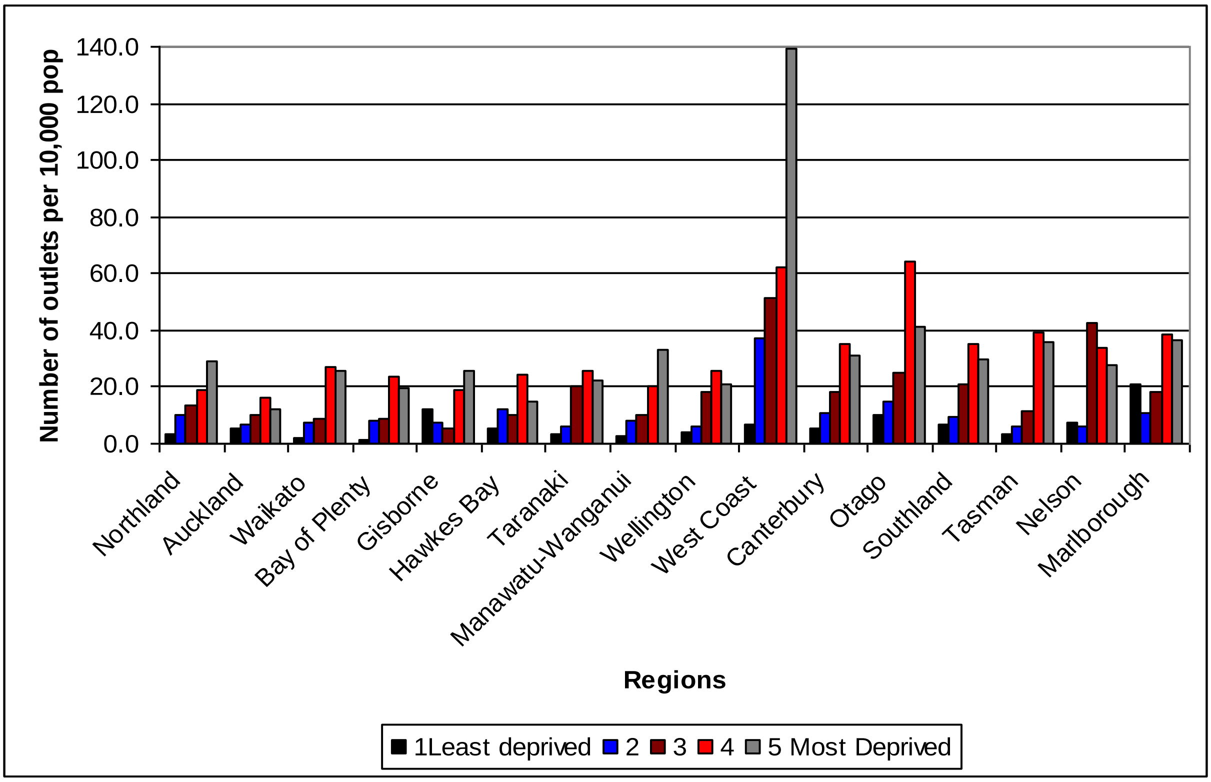
The previous section focussed on differences at the urban and rural level. This section examines access to outlets at a regional level. The first step is to calculate the rates of outlets per 10 000 population for 16 different administrative regions in New Zealand, stratified by deprivation quintiles. While more deprived areas have more liquor outlets per capita, the extent of this difference varies by region. Table 6.5 shows that the ratio between the different rates of outlets between the least deprived and most deprived is over one for all the regions. This showed that an increased number of outlets were associated with greater deprivation. The figures vary from a difference of 1.7 in Marlborough to 20 in the West Coast. In the main regions, Canterbury has about six times more outlets in most deprived areas, Wellington has five and Auckland has two. Generally, there is a social gradient in all the regions.

Table 6.5: Rates of alcohol outlets per 10 000 population in meshblocks by deprivation quintiles in New Zealand regions

		Deprivation Quintiles					
Region	**Population 2006**	**1 Least deprived**	**2**	**3**	**4**	**5 Most Deprived**	**Ratios Q5:Q1**
Northland	148 437	3.1	10.0	13.6	19.1	29.4	**9.3**
Auckland	1 303 068	5.3	6.6	10.4	15.9	12.2	**2.3**
Waikato	382 779	2.2	7.1	9.1	26.8	26.0	**11.6**
Bay of Plenty	257 544	1.6	8.1	8.5	23.9	19.5	**12.1**
Gisborne	44 433	12.1	7.3	5.2	19.2	25.7	**2.1**
Hawkes Bay	147 804	5.1	12.3	10.0	24.5	15.1	**2.9**
Taranaki	104 178	3.2	6.4	20.5	26.0	22.5	**7.1**
Manawatu-Wanganui	222 351	2.9	8.1	10.1	20.5	32.8	**11.4**
Wellington	448 914	4.2	6.4	18.4	26.0	20.6	**5.0**
West Coast	31 371	7.0	37.0	51.3	62.1	139.6	**20.0**
Canterbury	521 862	5.3	11.1	18.5	35.5	31.4	**5.9**
Otago	193 863	10.0	14.6	25.2	64.5	41.1	**4.1**
Southland	90 843	7.1	9.3	21.1	35.1	29.7	**4.2**
Tasman	44 580	3.1	5.9	11.4	38.9	35.8	**11.5**
Nelson	42 927	7.4	6.4	42.4	33.8	27.5	**11.3**
Marlborough	42 573	21.1	10.6	18.3	38.4	36.4	**1.7**

Figure 6.14 shows similar results but in bar graphs to better illustrate the difference between the most deprived and the least deprived areas. For all the regions, the bar graph (grey) for the most deprived areas is consistently higher than the least deprived areas.

Figure 6.14: Rates of alcohol outlets per 10 000 population in meshblocks by deprivation quintiles in New Zealand regions



The analysis was further stratified by different categories of alcohol outlets. There are variations with more bottle stores in the most deprived areas in all of the regions except three (Table 6.6): Marlborough, Nelson and Tasman. The regions with the largest ratio, showing that the proportion of bottle stores is 12 times higher more in the most deprived areas than the least deprived are Waikato, followed by Manawatu-Wanganui and Canterbury, where the proportion is 11 times higher. The differences in proportion range from 1.8 in Southland to 12.3 in Waikato.

Table 6.6: Rates of bottle stores per 10 000 population in meshblocks divided by deprivation quintiles in New Zealand regions

Bottle stores						
	Deprivation Quintiles					
Region	**1 Least deprived**	**2**	**3**	**4**	**5 Most deprived**	**Ratios Q5:Q1**
Northland	0.0	2.5	2.3	2.8	3.1	**3.1**
Auckland	1.9	2.5	3.4	4.6	3.5	**1.9**
Waikato	0.3	1.6	1.7	4.1	4.0	**12.3**
Bay of Plenty	0.5	2.5	2.0	2.9	3.0	**5.5**
Gisborne	2.4	1.8	1.7	5.6	5.4	**2.3**
Hawkes Bay	0.4	2.1	0.3	3.1	1.3	**3.0**
Taranaki	0.8	0.0	1.9	2.4	1.7	**2.2**
Manawatu-Wanganui	0.3	0.0	0.6	1.2	3.7	**11.5**
Wellington	0.8	1.7	2.4	3.1	3.9	**4.9**
West Coast	0.0	1.6	0.0	2.7	4.0	**4.1**
Canterbury	0.5	0.7	2.4	3.4	5.7	**11.0**
Otago	1.5	0.4	2.6	5.5	6.3	**4.2**
Southland	0.4	0.4	1.3	1.6	0.8	**1.8**
Tasman	1.0	0.0	0.0	7.8	0.0	**0.0**
Nelson	5.6	0.8	6.2	7.1	3.2	**0.6**
Marlborough	4.4	1.9	0.9	1.9	0.0	**0.4**

For hotel, taverns, bars and clubs all the 16 regions have more outlets in the most deprived areas compared to the least deprived areas per 10 000 population. The ratios vary from 36.5 in the West Coast to 1.8 in Gisborne (Table 6.7).

Table 6.7: Rates of hotels, taverns, bars and clubs per 10 000 population in meshblocks by deprivation quintiles in New Zealand regions

	Hotels/Taverns/ Bars/Clubs					
	Deprivation Quintiles					
Region	**1 Least deprived**	**2**	**3**	**4**	**5 Most deprived**	**Ratios Q5:Q1**
Northland	3.1	6.0	8.4	13.6	21.0	**6.7**
Auckland	2.6	3.1	5.7	9.5	7.0	**2.7**
Waikato	1.6	5.0	5.1	18.1	17.7	**11.0**
Bay of Plenty	0.8	4.0	4.7	17.8	12.3	**15.2**
Gisborne	9.7	3.7	3.5	10.2	17.8	**1.8**
Hawkes Bay	4.7	7.8	9.0	18.2	10.9	**2.3**
Taranaki	2.4	4.1	15.6	19.7	16.7	**7.1**
Manawatu-Wanganui	1.6	7.5	8.2	14.9	24.6	**15.4**
Wellington	1.7	2.5	13.0	18.0	10.9	**6.5**
West Coast	3.5	29.0	46.5	52.2	127.5	**36.5**
Canterbury	4.2	9.0	12.6	27.1	21.1	**5.0**
Otago	6.8	13.1	19.2	49.6	29.6	**4.3**
Southland	5.8	7.3	17.9	30.9	28.1	**4.9**
Tasman	2.1	4.9	6.7	21.4	29.9	**14.4**
Nelson	1.9	4.0	31.1	22.2	12.9	**7.0**
Marlborough	15.5	7.7	14.6	29.0	30.4	**2.0**

Similar results were observed for supermarkets and general stores/dairies except for Southland where there are more supermarkets in the least deprived areas, although the difference is minimal (Table 6.8). The other regions have more supermarkets and general stores/dairies in the most deprived with ratios ranging from 15.8 in Bay of Plenty to about two in Auckland. In the main cities, Wellington and Auckland have a ratio of about three with Canterbury having a ratio of about nine.

Table 6.8: Rates of supermarkets and general stores/dairies per 10 000 population in meshblocks by deprivation quintiles in New Zealand regions

	Supermarkets and general stores/dairies					
	Deprivation Quintiles					
Region	**1 Least deprived**	**2**	**3**	**4**	**5 Most deprived**	**Ratios Q5:Q1**
Northland	0.0	1.5	2.9	2.8	5.3	**5.3**
Auckland	0.9	1.0	1.3	1.8	1.7	**1.9**
Waikato	0.3	0.5	2.3	4.6	4.4	**13.7**
Bay of Plenty	0.3	1.6	1.8	3.3	4.2	**15.8**
Gisborne	0.0	1.8	0.0	3.4	2.5	**2.5**
Hawkes Bay	0.0	2.5	0.7	3.1	2.9	**2.9**
Taranaki	0.0	2.3	3.0	3.9	4.0	**4.0**
Manawatu-Wanganui	1.0	0.6	1.3	4.4	4.5	**4.7**
Wellington	1.7	2.2	3.0	5.0	5.9	**3.5**
West Coast	3.5	6.4	4.8	7.2	8.1	**2.3**
Canterbury	0.5	1.3	3.5	5.0	4.6	**8.8**
Otago	1.7	1.1	3.3	9.3	5.1	**3.0**
Southland	0.9	1.5	1.9	2.6	0.8	**0.9**
Tasman	0.0	1.0	4.8	9.7	6.0	**6.0**
Nelson	0.0	1.6	5.2	4.4	11.3	**11.3**
Marlborough	1.1	1.0	2.7	7.5	6.1	**5.5**

6.5.2 Density of outlets (Buffers of 800 and 3000 metres)

The analysis for density of outlets at regional level shows that there are more meshblocks with two or more outlets in the most deprived areas. The results are similar to the urban results presented previously (figures not shown). For almost all the regions, the least deprived areas have more meshblocks without an outlet. Only Otago and Gisborne that have a reverse pattern with the most deprived areas having more meshblocks without any outlet. The results of analysing which meshblocks have one outlet or more within a radius 800 metres are mixed. In Bay of Plenty, there are more meshblocks in most deprived areas with one outlet while for Canterbury, there are more meshblocks with one outlet in the least deprived areas. A fairly consistent pattern is emerging where meshblocks in the most deprived areas have more outlets than those in the least deprived areas. For 75% of regions, except for Canterbury, Otago, Marlborough and Wellington, there are more neighbourhoods in the most deprived areas with more than five outlets within 800 or 3000 metres. Overall, for all regions, people in the most deprived areas have a wide choice of alcohol outlets within walking or driving distance while people in the least deprived have to walk or drive further to an alcohol outlet.

6.5.3 Regional distance to alcohol outlets

Similar to the whole of New Zealand, there is a variation in median distance to alcohol outlets (Table 6.9). What is consistent is that as deprivation increases, the median distance reduces. The median distance in each of the regions varied from the shortest of 707 metres in Nelson to the longer 2.6 kilometres in both Tasman and Northland. The regions with major cities, on average, were below the one kilometre threshold. Auckland's and Wellington's median distances were 828 metres, compared to Canterbury's 915 metres. The average distance varied between the deprivation quintiles. The shortest distances in quintile five (the most deprived), were found in Otago (407 metres) followed by Tasman (543 metres). For the least deprived, the shortest distance was in Auckland at slightly over one kilometre followed by Nelson at 1.2 kilometres, otherwise all regions had a threshold of over 1km for the least deprived areas.

Table 6.9: Median distance in metres to alcohol outlets by deprivation quintiles in New Zealand regions

	Deprivation quintiles					
Region	**1 Least deprived**	**2**	**3**	**4**	**5 Most deprived**	**Median distance**
Northland	3868	3740	2652	2323	1592	2613
Auckland	1038	854	837	773	681	828
Waikato	3013	3291	2809	974	760	1418
Bay of Plenty	1912	2010	1446	929	883	1177
Gisborne	1594	2177	5926	991	995	1359
Hawkes Bay	1980	2056	1112	917	923	1166
Taranaki	2482	3217	1355	788	855	1325
Manawatu-Wanganui	2810	3832	1546	893	728	1213
Wellington	1249	962	681	573	627	828
West Coast	1564	2678	2327	618	427	903
Canterbury	1590	1153	822	607	612	915
Otago	2150	1489	884	532	407	990
Southland	5183	5272	1033	777	613	1341
Tasman	2566	4219	4648	1309	543	2681
Nelson	1275	872	629	552	620	708
Marlborough	2031	2262	1520	587	659	1405

6.5.4 Distance to different category of alcohol outlets

The median distance to the each of the alcohol outlets was calculated for all the regions for the different categories of alcohol outlets. There are variations in distance between deprivation quintiles and category and type of outlet. Generally, those in deprived areas travel shorter distances to alcohol retail outlets, but there are some exceptions to this. Table 6.10 shows that the median distance is shorter to bottle stores for most meshblocks in the most deprived regions compared to meshblocks in the least deprived. In Auckland, the median distance to a bottle store in the least deprived areas is 1018 metres compared to 682 metres in the most deprived areas. Canterbury has similar figures where the distance for the least deprived was 1149 metres compared to 695 metres for the most deprived. Table 6.10 also shows the ratios for all regions. The biggest distance difference between quintile one and five was in Otago where those in the least deprived areas have nearly five times more distance to travel to alcohol outlets, compared to those in the most deprived areas. Interestingly, in Marlborough, there are no bottle stores in the most deprived areas, while in the West Coast there are no bottle stores in the least deprived neighbourhoods.

Table 6.10: Median distance in metres to bottle stores by deprivation quintiles in New Zealand regions

	Deprivation quintiles					
Region	**1 Least Deprived**	**2**	**3**	**4**	**5 Most deprived**	**Ratios Q1/Q5**
Auckland	1018	805	797	759	683	**1.5**
Bay of Plenty	1701	1493	978	1152	880	**1.9**
Canterbury	1149	946	737	617	695	**1.7**
Gisborne	1448	1256	6448	941	878	**1.6**
Hawke's Bay	1820	1460	1243	636	1108	**1.6**
Manawatu-Wanganui	1705	1440	996	863	573	**3.0**
Marlborough	1506	1104	706	536	0	**2.8****
Nelson	1341	896	573	435	632	**2.1**
Northland	4198	3818	5154	853	1138	**3.7**
Otago	2125	1012	1073	543	467	**4.6**
Southland	1084	1184	784	804	613	**1.8**
Taranaki	1897	4691	471	539	1143	**1.7**
Tasman	1195	1563	1135	687	445	**2.7**
Waikato	1563	2008	1474	1010	787	**2.0**
Wellington	1263	883	567	582	600	**2.1**
West Coast	0	3027	794	372	466	**6.5***

* Ratio Q2:Q5
** Ratio Q1:Q4

Similar results were observed for the median distances to hotels, bars, taverns, and clubs. The median distances to hotels, bars, taverns, and clubs in the least deprived areas are higher than in the most deprived areas (Table 6.11). For example, in Waikato the median distance in the least deprived area is 5432 metres compared to 717 metres in the most deprived. Table 6.11 shows that those in the least deprived neighbourhoods of Waikato travel almost eight times further to hotels, bars, taverns, and clubs than those in the most deprived neighbourhoods. The ratios for quintile one and five were all above one showing that the most deprived meshblocks in all regions were travelling shorter distances to hotels, bars, taverns, and clubs in all the regions.

Table 6.11: Median distance in metres to hotels, taverns, bars/clubs by deprivation quintiles in New Zealand regions

	Deprivation quintiles					
Region	**1 Least Deprived**	**2**	**3**	**4**	**5 Most deprived**	**Ratios Q1/Q5**
Auckland	1196	1017	948	836	732	**1.6**
Bay of Plenty	2066	2446	1750	789	902	**2.3**
Canterbury	1750	1213	835	597	556	**3.1**
Gisborne	4017	7914	9604	1741	2134	**1.9**
Hawke's Bay	2561	2661	1162	987	794	**3.2**
Manawatu-Wanganui	4650	4825	2345	960	812	**5.7**
Marlborough	3944	4605	2399	570	850	**4.6**
Nelson	1612	861	546	404	428	**3.8**
Northland	3932	4562	3498	3832	2256	**1.7**
Otago	2419	1552	897	510	394	**6.1**
Southland	6730	6326	1219	809	613	**11.0**
Taranaki	3295	4360	1741	808	810	**4.1**
Tasman	3388	5874	4771	890	608	**5.6**
Waikato	5433	4598	5579	1282	717	**7.6**
Wellington	1167	1032	666	548	677	**1.7**
West Coast	1547	3171	2608	658	413	**3.7**

Table 6.12 shows a similar trend for supermarkets and general stores/dairies, except for Tasman where those in the most deprived neighbourhoods have to travel a distance almost 10 times greater than those in the least deprived neighbourhoods to access a supermarket or a general store/dairy.

Table 6.12: Median distance in metres to supermarkets and general stores/dairies by deprivation quintiles in New Zealand regions

	Deprivation quintiles					
Region	**1 Least deprived**	**2**	**3**	**4**	**5 Most deprived**	**Ratios Q1/Q5**
Auckland	897	858	809	686	599	**1.5**
Bay of Plenty	1838	2086	1595	949	865	**2.1**
Canterbury	1445	1160	852	610	617	**2.3**
Gisborne	1411	1587	937	1050	920	**1.5**
Hawke's Bay	1662	1032	980	944	1013	**1.6**
Manawatu-Wanganui	2359	3306	1204	831	719	**3.3**
Marlborough	2805	1512	853	607	569	**4.9**
Nelson	1141	958	774	615	692	**1.6**
Northland	2952	2565	1621	1912	994	**3.0**
Otago	1575	1447	781	668	529	**3.0**
Southland	4781	5368	948	440	2199	**2.2**
Taranaki	2169	1577	1292	856	835	**2.6**
Tasman	1428	4172	6605	9644	25120	**0.1**
Waikato	2768	2081	1654	755	770	**3.6**
Wellington	1275	950	772	613	626	**2.0**
West Coast	1913	762	1075	652	476	**4.0**

6.6 Summary

There is evidence of geographical variation in the provision of alcohol outlets in New Zealand. The major theme from the analysis is that those in the most deprived areas have better access to alcohol outlets, whether this is measured by travel distance or by density. This relationship is still strong at both the urban/rural or regional levels. Whilst there are differences in distance and density, the relationship is more pronounced when the variables are stratified by deprivation.

There is a relationship between access and density of alcohol outlets and deprivation. When alcohol outlet density is stratified by deprivation, the results show that the number of alcohol outlets per 10 000 population is four times greater amongst the most deprived quintiles compared to the least deprived quintiles. In terms of access, distances in the most deprived areas were at least two times shorter than in the least deprived areas. This pattern was also manifested at both national and regional levels, and in both urban and rural areas. Nationally, median distance to all alcohol outlets in the most deprived areas was 727 metres compared to 1.5 kilometres for the least deprived. This observation shows that people living in the least deprived quintile travel twice the distance as those living in the most deprived quintiles to reach an alcohol outlet. At regional level the distances varied, with shorter median distances found within the most deprived quintiles, in some areas. These distances were even shorter than the national average of 727 metres. For example, in Otago the median distance in the least deprived areas was 540 metres. When buffers of 800 metres and 3000 metres were considered, the results followed the same pattern as other access measures, where those in the most deprived areas had more outlets within walking and driving distance compared to those in the least deprived areas. The latter often had no, or few, outlets within the same buffer zone. These results were consistent for regions and for urban/rural location.

A calculation of rate of alcohol outlets per 10 000 revealed an interesting finding that, despite the fact that there are fewer bars in the rural areas, the number of bars per person is on average higher (24 per 10 000) than in the urban areas (14 per 10 000). Other differences were observed in density, where the urban areas have more outlets within the 800 metre and 3000 metre buffers, while for rural areas, most neighbourhoods had no outlets within the 800 or 3000 metre buffers. In rural areas, more neighbourhoods have seven or more outlets are located in the least deprived areas than in the more deprived areas, a notable difference from the urban areas. Distribution of alcohol outlets in rural areas is different than from urban areas, whilst outlets in urban areas are concentrated in one place, the rural outlets are geographically dispersed.

At the regional level, since the geographical area is larger, the differences also varied. For example, the difference between quintile five and one in rates per 10 000 outlets was large in some areas. There were areas with a tenfold difference including; Bay of Plenty (12) and West Coast (20). Other areas with sizeable differences included; Nelson (11.5), Tasman (11.3), Waikato (11.6) and Manawatu-Wanganui (11.4), showing that some areas have many outlets per 10 000 within their locality. Clearly, there are variations at regional level and some regions have higher rates than others, with different implications for each in terms of consumption. There are areas with less difference, which can be attributed to each of the regions being either more rural or more urban, thus influencing distribution.

6.7 Conclusion

This study has shown that the social-spatial distribution of alcohol outlets varies by deprivation, a result consistent with studies conducted in New Zealand and elsewhere. For all geographical locations, meshblocks, urban/rural locations and regions, there is a social gradient with increasing number of outlets associated with areas of greater deprivation. Significantly, at all these levels, even when population was taken into account, there was evidence that there were higher rates of alcohol outlets in the most deprived areas. There were shorter median travel distances in the most deprived areas in all the geographical locations studied even though rural areas have typically longer distances to travel than urban. When the density of alcohol outlets was calculated for buffers of 800 metres and 3000 metres, the most deprived areas had many neighbourhoods with more than one outlet compared to the least deprived with often no outlets. These results indicate that deprived areas have a greater concentration of, and easier access to, alcohol outlets no matter what the geographical location or level in New Zealand. People in deprived areas have better access to a range of alcohol outlets whether measured by type (on-or off-license) or category (e.g. supermarket, general stores/dairies, taverns).

The next chapter discusses binary logistic regression modelling, a hierarchical analysis between individual consumption and access to and density of alcohol outlets. Binary logistic regression modelling will be used to establish whether measures of alcohol outlet accessibility have an independent effect on individual hazardous alcohol consumption and frequent consumption (five or more drinks as defined in the New Zealand Health Survey) after controlling for other potential confounding factors.

Chapter 7 Access to alcohol outlets and alcohol-related behaviour

The main aim of this chapter is to determine the independent effect of proximity to alcohol outlets (measured in a number of ways) and the association with alcohol-related individual behaviour from the New Zealand Health Survey 2006/7 (NZHS 2006/07). Chapter 6 discussed the measures developed regarding access to alcohol outlets and found that alcohol outlets were mostly located in deprived areas. The NZHS 2006/07 indicated that hazardous and other adverse consumption patterns were mostly concentrated in deprived neighbourhoods, but the reason for this association was not well-established. The association between the number of alcohol outlets and deprivation has been well-established (Chapter 6), but it is less clear whether access to alcohol outlets has a relationship with alcohol-related consumption behaviour, whether in New Zealand or internationally. This chapter investigates the relationship between proximity to alcohol outlets and alcohol-related behaviour from the NZHS 2006/7, using a variety of access and density measures. To investigate this relationship, three questions were examined;

- Does living closer to alcohol outlets make an independent contribution to hazardous alcohol consumption and/or heavy episodic drinking for individuals in New Zealand after controlling for potential confounding individual and area level variables?
- Is living closer to alcohol outlets associated with a greater likelihood of frequent alcohol consumption in the last 12 months, after controlling for other individual and area level variables?
- Is living closer to alcohol outlets associated with a greater likelihood of frequent heavy episodic drinking (consuming more than five drinks at any one occasion whether on a monthly, weekly, or daily basis) after controlling for other individual and area level variables?

This chapter begins by discussing the data and methods used in the analysis. Descriptive statistics are first presented showing the sample distribution and prevalence of different alcohol-related behaviours from the NZHS 2006/07.

Table 7.1: Structure of chapter

		Hazardous consumption	Frequent consumption
Distance measures	Binary logistic regression	(n=9980) 0 = Non-Haz 1= Haz	(n=10 012) 0 = Non Freq 5 1 = Freq 5
Nearest distance to alcohol outlet	**National**		
	Whole population	√	√
1 = 0–571m	**Sub-Population**		
2 = 572m–995m	Age and Gender	√	√
3 = 996–2160m	Ethnicity, age and gender	√	√
4 = >2161m	**Rural urban**		
	Whole Population	√	√
	Age and gender	√	√
Density measures			
Buffers of 800 metres	**National**		
0 = No outlet	Whole population	√	√
1 = 1–2 outlets	**Sub-Population**		
2 = 3–6 outlets	Age and Gender	√	√
3 = >7 outlets	Ethnicity, age and gender	√	√
	Rural urban		
	Whole Population	√	√
	Age and gender	√	√
Buffers of 3000 metres	**National**		
0 = No outlet	Whole population	√	√
1 = 1–13 outlets	**Sub-Population**		
2 = 14–37 outlets	Age and Gender	√	√
3 = >38 outlets	Ethnicity, age and gender	√	√
	Rural urban		
	Whole Population	√	√
	Age and gender	√	√

Key
Non-Haz = Non-hazardous, AUDIT score less than 8.
Haz = Hazardous consumption, AUDIT score of 8 or more.
Non- Freq 5 = consuming 5 drinks or more (on one occasion) less than once a month or never
Freq 5 = consuming 5 drinks or more (on one occasion) monthly, weekly or daily.
All subsequent analysis will use the abbreviated name of variables.

The structure of the chapter is summarised in Table 7.1 which illustrates that Binary Logistic Regression analysis will be undertaken for each distance or density measure at national level, then the whole population, followed by sub-populations and finally by urban/rural location stratified by sub-groups. Next the results of binary logistic regression analysis are presented, indicating how access measures predicted alcohol-related behaviour at the national level. Further analysis will be performed to examine whether alcohol-related behaviour of different population sub-groups by age, gender, ethnicity, urban/rural location and socio-economic status differed according to their level of access to alcohol outlets.

7.1 Data

As illustrated in Chapter 6, data derived for this analysis included distance to the nearest alcohol outlet venues, divided into four equal quartiles with each quartile having approximately 9950 meshblocks. This stratification was necessary to meet the ethical confidentiality requirement of Ministry of Health in order to access the survey. In addition, the number of all alcohol outlets within walking distance (800 metres) of meshblocks was established. Since this data was skewed, density was categorised into four parts with neighbourhoods having no outlets comprising approximately 40% of meshblocks and the other three categories each having approximately 20%. Similarly, for the number of alcohol outlets within a driving distance (3000 metres), the skewed data was also categorised into four parts with neighbourhoods having no outlets comprising approximately 16% of the total and the other three categories each having approximately 28% of the meshblocks (Table 7.1).

After developing access measures, an Excel spread sheet was sent to the Ministry of Health where the NZHS (2006/07) data was appended and all meshblock names and numbers removed for confidentiality purposes. No individuals or small geographical areas were allowed to be identified by the data. The data appended from the survey included alcohol-related consumption patterns (Table 7.7), plus individual characteristics, including age groups, gender, ethnicity, personal income and individual deprivation

Binary logistic analysis was used to examine the association between the exposure variables, proximity to alcohol outlets and two outcome variables: hazardous consumption and frequent consumption (of five or more drinks on a frequent basis whether monthly, weekly or daily). As illustrated in Table 7.1 each type of the alcohol-related behaviour was separated into two groups. First, hazardous drinkers were compared with non-hazardous drinkers. Secondly, for frequency of consumption, the comparison was between people who consumed less and those consumed more heavily on a regular basis. Of those who consume five or more drinks monthly, weekly or daily, 65.4% (CI 62.9–67.9) were also hazardous consumers, indicating an overlap between the two measures.

There are several covariates, mentioned in the literature review in Chapters 2 and 3, which were selected for inclusion in the models. These compositional and contextual variables have a relationship with alcohol consumption and include age, gender, ethnicity, personal income, individual deprivation, urban/rural location and area deprivation (Table 7.7). These were all selected because of their possible role as confounders, as explained in chapter 4. All individual variables were derived from the NZHS (2006/07), while the contextual factors, urban/rural location and area deprivation were derived from the 2006 census. To establish that contextual factors are important, the research must be able to control for potential confounding variables and still have a significant relationship once this has been done (Do and Finch, 2008, Pickett and Pearl, 2001).

7.2 Analysis steps

As illustrated in Chapter 4, the first step was to undertake descriptive analyses of the NZHS 2006/2007 data. This showed the prevalence of hazardous and frequent consumption of alcohol stratified by age, gender and ethnicity. Summary statistics of demographic and socio-economic variables used in the regressions are presented in Section 7.3. In addition, the association between alcohol-related behaviour and socio-demographic variables, as well as area deprivation and access measures have been tested by chi-square.

Binary logistic regression was undertaken to examine the association between the exposure variable (proximity to alcohol outlets) and two outcome variables; hazardous consumption and the frequent consumption of five or more drinks on one occasion on a regular basis, hereafter referred to as frequent consumption. Analysis was undertaken only for people over 15 years of age who reported the consumption of alcohol in the last 12 months, therefore abstainers were excluded (Section 7.4). Tests of trends for exposure variables were undertaken by fitting the categorical variables as continuous measures while examining whether the p value was statistically significant ($p < 0.05$).

Alcohol accessibility variables were added in each model, while controlling for potential confounding factors. The models produced included seven stages;

- a baseline model
- age and gender model
- ethnicity models
- individual SES model
- individual deprivation model
- urban/rural model
- NZ deprivation model.

Chapter 4 illustrated the different models starting at baseline, where univariate associations between neighbourhood variables and alcohol-related behaviour were tested. In model 1, gender and age were added as control variables and changes in the relationship between neighbourhood variables and alcohol-related behaviour were monitored. This was to examine whether the relationship between the outcome and exposure variables was modified by age and gender. Model 2 was adjusted for ethnicity. Models 3and 4 were adjusted for two socio-economic measures, personal income and individual deprivation respectively. Model 5 was adjusted for urban/rural location and finally model 6 was adjusted for area deprivation. Table 7.2 shows a typical model; however, depending on the subpopulation being examined the structure might change. For example, when examining age and gender, ethnicity was model one, because age and gender were already controlled for. Similarly when examining urban/rural sub-populations, deprivation was the variable for model 5.

Table 7.2: Models for examining the relationship between access to alcohol outlets and alcohol consumption

Baseline Model	**Model 1: Age and Gender**	**Model 2: Ethnicity**	**Model 3: Individual SES**	**Model 4: Individual deprivation**	**Model 5: Urban/rural**	**Model 6: Area deprivation**
Survey design settings	Survey design settings	Survey design settings	Survey design settings	Survey Design settings	Survey design settings	Survey design settings
Dependent variable: alcohol consumption/ behaviour	Dependent variable: alcohol consumption/ behaviour	Dependent variable: alcohol consumption/ behaviour	Dependent variable: alcohol consumption/ behaviour	Dependent variable: alcohol consumption/ behaviour	Dependent variable: alcohol consumption/ behaviour	Dependent variable: alcohol consumption/ behaviour
Exposure variable: access and density of alcohol outlets	Exposure variable: access and density of alcohol outlets	Exposure variable: access and density of alcohol outlets	Exposure variable: access and density of alcohol outlets	Exposure variable: access and density of alcohol outlets	Exposure variable: access and density of alcohol outlets	Exposure variable: access and density of alcohol outlets
	Age and gender	Age and gender	Age and gender	Age and gender	Age and gender	Age and gender
		Ethnicity	Ethnicity	Ethnicity	Ethnicity	Ethnicity
			Personal income	Personal income	Personal income	Personal income
				Individual deprivation	Individual deprivation	Individual deprivation
					Urban Rural	Urban Rural
						Area deprivation

7.3 Descriptive results

The NZHS interviewed respondents aged 15 years and over and, among other things, they were questioned about their drinking behaviour in the past year. Details of the survey were discussed in Chapter 4. Table 7.3 illustrates that 21.1% (CI 20.0–22.2) of the total population aged 15 years and over, who consumed alcohol in the last year were hazardous consumers and 26.4 % (CI 25.3–27.7) were frequent consumers.

Table 7.3: Descriptive statistics showing alcohol-related behaviour for respondent aged 15 years and over from the New Zealand Health Survey 2006/07

	Descriptive statistics			
Variables	**Number**	**Proportion %**	**LCI**	**UCI**
Hazardous	2 161	21.1	20.0	22.2
Non-Hazardous	7 819	78.9	77.7	80.0
Total	**9 980**	**100.0**		
Freq 5	2 629	26.4	25.3	27.7
Non-Freq 5	7 383	73.5	72.3	74.7
Total	**10 012**	**100.0**		

Non-Haz = Non-hazardous consumption, AUDIT score less than 8.

Haz = Hazardous consumption, AUDIT score of 8 or more.

Non- Freq 5 = consuming 5 drinks or more (on one occasion) less than once a month or never

Freq 5 = consuming 5 drinks or more (on one occasion) monthly, weekly or daily.

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

When stratified by gender (Table 7.4), hazardous consumption was more prevalent in men than women, with men more than twice as likely to consume alcohol hazardously compared to the women (29.2% (CI 27.4–30.9) versus 13% (CI 11.7–14.3)). Similarly for frequent consumption of five or more drinks, males had higher rates than females, a result consistent with other studies (WHO 2004) and illustrating that the prevalence of all forms of heavy consumption is significantly higher in males.

Table 7.4: Descriptive statistics showing alcohol-related behaviour for different genders aged 15 years and above from the New Zealand Health Survey 2006/07

	Male			**Female**		
	Haz	Non-Haz	**Total**	Haz	Non-Haz	**Total**
Number	1 331	3 173	**4 504**	830	4 646	**5 476**
%	29.2	70.8	**100**	13.0	87.0	**100**
LCI	27.4	69.1		11.7	85.7	
UCI	30.9	72.6		14.3	88.3	
Frequency of consuming five or more drinks						
	Freq 5	Non-Freq 5	**Total**	Freq 5	Non-Freq 5	**Total**
Number	1 625	2 894	**4 519**	1 004	4 489	**5 493**
%	36.4	63.6	**100**	16.5	83.5	**100**
LCI	34.6	61.8		15.1	82.1	
UCI	38.2	65.4		17.9	84.9	

Non-Haz = Non-hazardous consumption, AUDIT score less than 8.

Haz = Hazardous consumption   AUDIT score of 8 or more.

Non- Freq 5 = consuming 5 drinks or more (on one occasion) less than once a month or never

Freq 5 = consuming 5 drinks or more (on one occasion) monthly, weekly or daily.

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Stratified by age, Table 7.5 illustrates that hazardous consumption was more prevalent in younger age groups (41.1%, CI 37.3–44.8), with decreasing proportions as people age. For frequent consumption, the younger age groups 15-24 had the highest rates. Hazardous consumption and frequent consumption in the last year was therefore most characteristic of younger age groups aged 15-24 years.

Table 7.5: Descriptive statistics showing alcohol-related behaviour from different age-groups from the New Zealand Health Survey 2006/07 (Respondents aged 15 years and above)

Age groups	Alcohol consumption	Number	%	LCI	UCI	Consumption of five or more drinks (frequency)	Number	%	LCI	UCI
15–24	Haz	612	41.1	37.3	44.8	Freq 5	647	43.6	39.9	47.3
	Non-haz	754	58.9	55.2	62.7	Non-Freq 5	729	56.4	52.7	60.1
25–34	Haz	497	27.1	24.3	29.9	Freq 5	603	34.9	31.9	37.8
	Non-Haz	1 202	72.9	70.1	75.7	Non-Freq 5	1 105	65.1	62.2	68.1
35–44	Haz	457	19.2	17.1	21.2	Freq 5	581	26.2	23.9	28.4
	Non-Haz	1 629	80.8	78.8	82.9	Non-Freq 5	1 509	73.8	71.6	76.1
45–54	Haz	286	14.2	12.1	16.2	Freq 5	390	21.6	19.2	24.0
	Non-Haz	1 407	85.8	83.8	87.9	Non-Freq 5	1 307	78.4	76.0	80.8
55–64	Haz	182	14.0	11.7	16.3	Freq 5	252	18.5	16.0	21.1
	Non-Haz	1 234	86.0	83.7	88.3	Non-Freq 5	1 168	81.5	78.9	84.0
65–74	Haz	93	9.1	7.1	11.1	Freq 5	124	12.2	9.9	14.6
	Non-Haz	907	90.9	88.9	92.9	Non-Freq 5	877	87.8	85.4	90.1
75+	Haz	34	5.2	3.2	7.1	Freq 5	32	4.8	2.9	6.8
	Non-Haz	686	94.8	92.9	96.8	Non-Freq	688	95.2	93.2	97.1

Non-Haz = Non-hazardous consumption - AUDIT score less than 8.

Haz = Hazardous consumption - AUDIT score of 8 or more.

Non- Freq 5 = consuming 5 drinks or more (consumed on one occasion) less than once a month or never

Freq 5 = consuming 5 drinks or more (consumed on one occasion) monthly, weekly or daily.

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Further analysis for all ethnic groups (Table 7.6) illustrated that Māori and Pacific Island people were more than twice likely to consume alcohol hazardously than Europeans. Similar results were reported for the consumption of five or more drinks frequently. These results indicate that a significant number (42%) of Māori and Pacific Island people consume five or more drinks on regular occasions.

Table 7.6: Descriptive statistics showing alcohol-related behaviour from different ethnic groups aged 15 years and over from the New Zealand Health Survey 2006/07

	Māori		**Pacific Island**		**Asian**		**European/ other**	
	Haz	Non-Haz	Haz	Non-Haz	Haz	Non-Haz	Haz	Non-Haz
Number	970	1610	184	344	64	806	943	5 059
%	39.2	60.8	39.0	61.0	8.9	91.1	18.7	81.3
LCI	36.7	58.4	33.8	55.8	6.1	88.2	17.4	80.0
UCI	41.6	63.3	44.2	66.2	11.8	93.9	20.0	82.6
Frequency of consuming five or more drinks								
	Freq 5	Non-Freq 5	Freq 5	Non-Freq 5	Freq 5	Non-Freq 5	Freq 5	Non-Freq 5
Number	1 054	1 539	203	331	97	775	1 275	4 738
%	43.2	56.7	41.6	58.4	11.4	88.6	24.6	75.4
LCI	40.7	54.2	36.3	53.0	8.6	85.7	23.2	74.0
UCI	45.8	59.3	47.0	63.7	14.3	91.4	26.0	76.8

Non-Haz = Non-hazardous consumption - AUDIT score less than 8.

Haz = Hazardous consumption - AUDIT score of 8 or more.

Non- Freq 5 = consuming 5 drinks or more (consumed on one occasion) less than once a month or never

Freq 5 = consuming 5 drinks or more (consumed on one occasion) monthly, weekly or daily.

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Table 7.7: Sample distributions and prevalence of hazardous consumption for respondents aged 15 years and above from the New Zealand Health Survey 2006/07.

Socio demographic characteristics		**% of sample (n=9980)**	**% hazardous consumption (Overall 21.1%)**	**p value (two tailed χ^2)**
Age group	15–24	13.7	41.1	
	25–34	17.0	27.1	
	35–44	20.9	19.2	
	45–54	17.0	14.2	
	55–64	14.2	14.0	
	65–74	10.0	9.1	
	75+	7.2	5.2	p < 0.000
Gender	Female	54.9	13.0	
	Male	45.1	29.2	p < 0.000
Ethnicity	Māori	25.9	39.2	
	Pacific Island people	5.3	39.0	
	Asian	8.7	8.9	
	European/other	60.1	18.7	p < 0.000
Personal Income	0–20,000	39.0	21.3	
	20,001–40,000	29.1	22.4	
	40,001–80,000	25.4	22.6	
	>80,001	6.5	19.6	p < 0.309
Individual deprivation	1 No deprivation characteristic	63.3	16.9	
	2 One deprivation characteristic	17.0	25.1	
	3 Two deprivation characteristics	8.0	31.6	
	4 3/4 deprivation characteristics	7.8	33.1	
	5 Five deprivation characteristics	3.9	40.6	p < 0.000
Contextual factors				
Location	Urban	85.9	22.1	
	Rural	14.1	19.0	p < 0.010
Area Deprivation	1	17.6	15.9	
	2	18.3	16.8	
	3	20.6	19.5	
	4	21.5	22.6	
	5	22.1	31.3	p < 0.000
Access measures	Distance to alcohol outlets			
	1 = <571 metres	24.1	22.8	
	2 = 572-995metres	28.9	21.7	
	3 = 992-2160metres	30.2	22.4	
	4 = >2161 metres	16.8	18.6	p < 0.009
	Buffers of 800metres to alcohol outlets			
	0 =No Outlets	37.4	21.2	
	1 =1-2 Outlets	26.2	21.1	
	2 = 3-6 outlets	21.9	22.4	
	3=7+ outlets	14.5	22.8	p < 0.430
	Buffers of 3000metres to alcohol outlets			
	0 = No Outlet	9.7	18.5	
	1 = 1-13 outlets	29.1	22.7	
	2 = 14-37 outlets	33.2	20.9	
	3 = 38+ outlets	28.0	22.5	p < 0.022

Table 7.7 shows the proportions for the different variables that were used in the analysis. The percentages and prevalence are shown for age groups, gender, personal income, individual deprivation, urban/rural location and area deprivation estimated by

chi-square tests. The chi-square tests indicate that there was a statistically significant relationship between hazardous consumption and age group, gender, ethnicity, individual deprivation, urban/rural, area deprivation, distance, and buffers of 3000 metres to alcohol outlets.

People living in the most deprived areas had rates of hazardous consumption that were twice those of people living in the least deprived areas. Only personal income and buffers of 800 metres had no association with hazardous alcohol consumption. The chi-square tests showed no significant associations for frequent consumption with any of the following variables: buffers of 800 metres, distance measures, urban/rural location, see Appendix 13.

The next step was to determine whether the odds of hazardous and frequent consumption, were associated with proximity to alcohol outlets. This section presents the results for the relevant binary logistic regressions and begins by evaluating univariate associations between distance to alcohol outlets and hazardous consumption. The analysis was undertaken in four steps as explained in Table 7.1 above.

The results are presented at the national level for hazardous consumption and distance to alcohol outlets. Based on the statement of Macintyre et al., (1993) that 'place' features may influence everyone living in the same area equally, or alternatively may influence certain groups more significantly, analysis was undertaken for different sub-population groups. These groups include different genders, age groups and ethnicity to identify which groups were most influenced by contextual factors. This analysis was repeated for frequent consumption of five or more drinks. Similar analysis was also undertaken for buffers of 800 metres and 3000 metres, and density measures, repeating all the steps outlined in Table 7.1.

7.4 Distance to alcohol outlets measures

As illustrated in Table 7.1, the distances to all alcohol outlets were calculated in GIS and divided into equal quartiles. Using alcohol-related behaviour as a dependent variable and distance to alcohol outlets as the exposure variable; binary logistic regression analysis was undertaken, reporting ORs. This section examines the relationship between the distance to alcohol outlets and alcohol-related behaviour beginning with hazardous consumption. The analysis is repeated for frequent consumption of five or more drinks.

7.4.1 Hazardous consumption

Hazardous consumption was calculated using the AUDIT score of eight or more, and was undertaken by the Ministry of Health. For this analysis, all people aged 15 and over, who were classified as drinkers, were further stratified into hazardous and non hazardous consumers (n = 9980).

7.4.1.1 Hazardous consumption nationally

Table 7.8 indicates the results of the binary logistic regression of distance to alcohol outlets, and selected control variables, on national hazardous and non-hazardous consumption. The baseline model shows that the odds ratios were slightly higher in the shortest distance to alcohol outlets, though the differences between the four distances were marginal, and the only significant distance was the furthest (>2.2 kilometres, p <0.05). The results show that those living furthest away were 24% less likely to consume hazardously when compared to those living within 571 metres. This is not surprising given the small distance involved, especially for the first two quartiles (<995 metres). In addition, the test of trends shows that this relationship was statistically significant (p <0.02), indicating that there was a gradient. As distance increased hazardous alcohol consumption reduced, indicating a negative association, people who lived closer to alcohol outlets had higher odds of hazardous consumption. After adjustment for individual characteristics, age and gender, the trend for distance was no longer apparent indicating that the difference in hazardous consumption was therefore mediated by differences in age and gender. There were no statistically significant associations when all the other control variables, ethnicity, personal income, individual deprivation, urban/rural location and area deprivation, were adjusted for.

Table 7.8: Binary logistic regression of national distance to alcohol outlets and control variables on hazardous consumption, while adjusting for a range of individual characteristics and contextual variables

	Baseline Model				**Model 1 age and Gender**				**Model 2 Ethnicity**				**Model 3 Personal income**				**Model 4 Individual deprivation**				**Model 5 Urban/rural**				**Model 6 Area Deprivation**			
Distance	Odds Ratio	LCI	UCI	p value	Odds Ratios	LCI	UCI	p value	Odds Ratio	LCI	UCI	p value	Odds Ratios	LCI	UCI	p value	Odds Ratios	LCI	UCI	p value	Odds Ratios	LCI	UCI	p value	Odds Ratios	LCI	UCI	p value
<571m	**1**				1				1				1				1				1				1			
572–995m	0.97	0.80	1.17	0.75	1.04	0.85	1.27	0.72	1.04	0.85	1.27	0.73	1.06	0.86	1.30	0.60	1.05	0.86	1.30	0.62	1.05	0.86	1.30	0.62	1.08	0.87	1.33	0.50
996m–2.1km	0.95	0.79	1.14	0.57	1.01	0.83	1.22	0.96	0.99	0.81	1.20	0.89	1.01	0.83	1.23	0.90	1.04	0.85	1.26	0.72	1.04	0.85	1.26	0.72	1.05	0.86	1.28	0.63
>2.2km	**0.76**	0.62	0.94	**0.01**	0.88	0.71	1.09	0.24	0.85	0.68	1.06	0.16	0.87	0.69	1.09	0.21	0.92	0.73	1.15	0.45	0.88	0.67	1.16	0.37	0.91	0.68	1.22	0.54
Test of trends	0.93	0.87	0.99	**0.02**	0.96	0.90	1.03	0.30	0.96	0.95	0.89	0.17	0.96	0.90	1.03	0.26	0.98	0.91	1.05	0.55	0.98	0.91	1.06	0.62	0.99	0.91	1.07	0.81
Gender																												
Female					**1**				**1**				**1**				**1**				**1**				1			
Male					**2.99**	2.60	3.44	**0.00**	**3.15**	2.73	3.64	**0.00**	**3.04**	2.62	3.54	**0.00**	**3.14**	2.70	3.66	**0.00**	**3.14**	2.69	3.66	**0.00**	**3.14**	2.69	3.66	**0.00**
Age groups																												
15–24					1				1				1				1				1				1			
25–34					**0.52**	0.42	0.64	**0.00**	**0.51**	0.41	0.64	**0.00**	**0.46**	0.36	0.58	**0.00**	**0.41**	0.32	0.52	**0.00**	**0.41**	0.32	0.52	**0.00**	**0.41**	0.32	0.52	**0.00**
35–44					**0.33**	0.26	0.40	**0.00**	**0.32**	0.26	0.40	**0.00**	**0.29**	0.23	0.37	**0.00**	**0.26**	0.21	0.33	**0.00**	**0.26**	0.20	0.33	**0.00**	**0.26**	0.21	0.33	**0.00**
45–54					**0.22**	0.18	0.29	**0.00**	**0.23**	0.18	0.29	**0.00**	**0.21**	0.16	0.27	**0.00**	**0.20**	0.15	0.26	**0.00**	**0.19**	0.15	0.26	**0.00**	**0.20**	0.15	0.26	**0.00**
55–64					**0.22**	0.17	0.28	**0.00**	**0.22**	0.17	0.29	**0.00**	**0.20**	0.15	0.27	**0.00**	**0.20**	0.15	0.26	**0.00**	**0.20**	0.15	0.26	**0.00**	**0.20**	0.15	0.26	**0.00**
65–74					**0.13**	0.10	0.18	**0.00**	**0.13**	0.10	0.18	**0.00**	**0.13**	0.10	0.18	**0.00**	**0.14**	0.10	0.20	**0.00**	**0.14**	0.10	0.20	**0.00**	**0.14**	0.10	0.20	**0.00**
75+					**0.07**	0.05	0.11	**0.00**	**0.08**	0.05	0.12	**0.00**	**0.08**	0.05	0.12	**0.00**	**0.09**	0.06	0.15	**0.00**	**0.09**	0.06	0.15	**0.00**	**0.09**	0.06	0.15	**0.00**
Ethnicity																												
Māori									**1**				**1**				**1**				**1**				**1**			
Pacific									0.84	0.65	1.10	0.22	0.81	0.62	1.06	0.12	0.79	0.60	1.04	0.09	0.79	0.60	1.05	0.10	0.79	0.60	1.05	0.10
Asian									**0.11**	0.08	0.16	**0.00**	**0.12**	0.08	0.17	**0.00**	**0.13**	0.09	0.19	**0.00**	**0.13**	0.09	0.20	**0.00**	**0.14**	0.09	0.20	**0.00**
Other									**0.24**	0.09	0.65	**0.01**	**0.29**	0.11	0.76	**0.01**	**0.28**	0.11	0.76	**0.01**	**0.29**	0.11	0.76	**0.01**	**0.29**	0.11	0.78	**0.01**
European									**0.44**	0.38	0.52	**0.00**	**0.44**	0.38	0.52	**0.00**	**0.49**	0.42	0.57	**0.00**	**0.49**	0.42	0.57	**0.00**	**0.50**	0.43	0.59	**0.00**

Personal income																
0 – 20000	**1**				**1**				**1**				**1**			
20001 – 40000	**1.32**	1.09	1.60	**0.00**	**1.48**	1.22	1.79	**0.00**	**1.48**	1.22	1.80	**0.00**	**1.49**	1.23	1.80	**0.00**
40001 – 80000	**1.33**	1.08	1.65	**0.01**	**1.69**	1.35	2.10	**0.00**	**1.70**	1.36	2.11	**0.00**	**1.71**	1.37	2.13	**0.00**
80000 and above	**1.20**	0.89	1.63	0.24	**1.60**	1.17	2.19	**0.00**	**1.61**	1.18	2.20	**0.00**	**1.63**	1.19	2.23	**0.00**
Individual dep																
1					**1**				**1**				**1**			
2					**1.40**	1.15	1.70	**0.00**	**1.40**	1.15	1.70	**0.00**	**1.39**	1.15	1.69	**0.00**
3					**2.30**	1.78	2.97	**0.00**	**2.30**	1.78	2.98	**0.00**	**2.28**	1.76	2.95	**0.00**
4					**1.89**	1.44	2.49	**0.00**	**1.90**	1.44	2.49	**0.00**	**1.85**	1.42	2.43	**0.00**
5					**3.01**	2.14	4.25	**0.00**	**3.01**	2.14	4.24	**0.00**	**2.94**	2.08	4.14	**0.00**
Urban/Rural																
Urban									**1**				**1**			
Rural									1.08	0.81	1.43	0.60	1.08	0.81	1.44	0.58
Area dep.																
Quintile 1													1			
Quintile 2													0.86	0.67	1.11	0.25
Quintile 3													0.94	0.75	1.19	0.63
Quintile 4													0.99	0.78	1.25	0.91
Quintile 5													1.09	0.84	1.43	0.52

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

All the potential confounding variables mediate in the relationship between distance and hazardous consumption. In short, after adjusting for confounding variables, the contextual variable distance to alcohol outlets was not a predictor of hazardous consumption for the general population, meaning that there was no 'geography'. (Geography hereafter means an association between alcohol-related behaviour and access measure).

This association was mediated by differences in individual characteristics, including age, gender, ethnicity, median income, and deprivation as well as contextual factors such as urban/rural location and area deprivation.

Although the focus of interest is on how proximity to alcohol outlets influences consumption, there are some other interesting results worth mentioning as they point towards further analysis of different sub-populations. For example, after controlling for age, males were three times more likely to consume hazardously than females; the younger age group aged 15–24 years had highest odds of hazardous consumption; and those aged 25–34 were 48% less likely to consume hazardously compared to the youngest age groups. As expected, there was a monotonic decrease in the ORs for hazardous consumption (OR = 0.52; OR = 0.33; OR = 0.22; OR = 0.13; OR = 0.07) as the age-groups of respondents rose from 25–34 years, 35–44 years, 45–64 years, 65–74 years and 75 years and over, respectively. Similarly, there were increases in ORs between the shortest and the longest distances, with age and gender as mediators. While adjusting for age and gender, the OR for the relationship between the longest distance and hazardous consumption increased by 15.7% (0.76–0.88 / 0.76), from the baseline, and was no longer statistically significant, emphasising the effect of age and gender as mediators, for if the relationship were to have remained significant, the figures should have decreased. Tables 7.4 and 7.5 illustrate that hazardous consumption was mostly in males of younger ages, therefore confounding the relationship with proximity to alcohol outlets and the general population. In addition, chi-square tests also indicated a significant relationship between hazardous consumption and age and gender.

After controlling ethnicity for age and gender, there was no statistical difference between the reference group Māori, and the Pacific Island population; however, for all other groups, Māori had higher odds of consumption. New Zealand Europeans were

56% less likely to consume alcohol hazardously when compared to Māori. The data for Māori and Pacific Island people were therefore combined for future analysis, since there was no statistically significant difference between them. Table 7.6 and Table 7.7 also indicate that Māori and Pacific Island persons hazardous consumption was almost equal at 39%, while frequent consumption of five drinks for Māori was 43.2 and 41.6 for Pacific Island persons. The differences between the two groups was minimal In addition, the NZHS (2006/07) reports that after controlling for age and gender, there was no statistical difference between Māori and Pacific Island hazardous consumption. All analysis from here onwards will combine both the ethnic groups, Māori and Pacific Island persons.

The analysis also showed that, after controlling for age, gender and ethnicity, those with higher personal income were at higher odds of consumption (OR = 1.32; CI 1.09–1.60; OR = 1.33; CI 1.08–1.65) for personal incomes of $20,001–40,000 and $40,001–60,000 dollars respectively, compared with those earning $0–20,000 as the reference group. The relationship was not statistically significant between the reference group and those with personal incomes of more than $80,000.

The association between individual deprivation and hazardous consumption was interesting. While people with five or more deprivation characteristics were three times more likely to consume hazardously compared to those with one, those with only three characteristics had higher odds than those with five. All the deprivation characteristics were significant at the 99% confidence level. There were no statistically significant relationships between hazardous consumption and urban/rural location, or with area deprivation after controlling for a range of variables.

While the control variables are not necessarily the main interest of this study, they provide a basis for further interrogation of some sub-population groups, such as the younger age group of 15–24 years, males, and also Māori and Pacific Island people.

According to Macintyre et al., (1993), there are some ‘place’ effects on some people in certain areas; therefore, the sub-population groups identified were age, gender and ethnicity. With the focus of interest on how the ORs of hazardous consumption vary by distance to alcohol outlets, the subsequent tables show only the distance variables and how they change after adjustment. Analyses were undertaken for different sub-populations namely age, gender and ethnicity.

7.4.1.2 Hazardous consumption by sub-population: Gender and Age

Since the initial results (Table 7.8) showed that there were interesting significant relationships between different sub-population groups, further analyses were undertaken for different genders. The first step was to examine whether male and female hazardous consumption was influenced by distance. After controlling for all the confounding variables, there was no association for male hazardous consumption and distance. The only association for female hazardous consumption was at baseline otherwise there was no association with distance after controlling for all the confounding variables, see Appendix 15. At baseline, females living furthest away from alcohol outlets (>2.2 kilometres) were 31% less likely to consume alcohol hazardously compared to those in the reference group (<571m). The test of trends was also significant in illustrating a gradient: There was a negative association between consumption and distance suggesting that consumption decreased with increasing distance away from an alcohol outlet. After adjusting for age, ethnicity and personal income, the relationship was no longer apparent for distance but the test of trends were significant; however, after adjusting for individual and area deprivation, even the test of trends was no longer significant.

Further analysis was performed for different genders by age group. Table 7.9 illustrates that there was no association of male and female hazardous consumption and distance by age group, except for males aged 75 and above. No other age group was significant nationally by gender. More analysis was undertaken for the identified age group.

Table 7.9: Binary logistic regression of distance to alcohol outlets and control variables on hazardous consumption for gender by age group

		Male					Female				
	Distance to alcohol outlets										
		<571m	572–995m	996m–2.1km	>2.2km	Test of trends	<571m	572–995m	996m–2.1km	>2.2km	Test of trends
15–24	**Odds Ratio**	1	1.02	1.08	0.85	0.98	1	1.69	0.84	0.77	0.86
	LCI		0.59	0.61	0.44	0.80		0.97	0.48	0.37	0.70
	UCI		1.77	1.92	1.63	1.19		2.97	1.49	1.61	1.06
	p value		0.95	0.79	0.62	0.81		0.07	0.55	0.48	0.17
25–34	**Odds Ratio**	1	1.06	1.63	1.73	1.25	1	0.77	0.84	0.73	0.92
	LCI		0.62	0.95	0.86	1.01		0.45	0.49	0.38	0.75
	UCI		1.83	2.79	3.48	1.54		1.30	1.42	1.39	1.12
	p value		0.82	0.08	0.12	0.04		0.33	0.51	0.34	0.38
35–44	**Odds Ratio**	1	0.66	0.92	0.82	0.97	1	0.93	0.84	0.60	0.86
	LCI		0.41	0.57	0.49	0.83		0.48	0.45	0.30	0.70
	UCI		1.06	1.48	1.38	1.15		1.80	1.58	1.22	1.06
	p value		0.09	0.73	0.45	0.76		0.83	0.60	0.16	0.16
45–54	**Odds Ratio**	1	0.82	0.59	0.94	0.94	1	0.98	0.91	0.76	0.92
	LCI		0.44	0.33	0.50	0.76		0.42	0.44	0.33	0.71
	UCI		1.53	1.09	1.74	1.16		2.28	1.90	1.79	1.19
	p value		0.53	0.09	0.84	0.54		0.95	0.81	0.53	0.51
55–64	**Odds Ratio**	1	1.18	1.24	0.83	0.95	1	2.41	1.63	1.86	1.11
	LCI		0.65	0.69	0.37	0.77		0.74	0.51	0.48	0.77
	UCI		2.16	2.23	1.84	1.19		7.78	5.27	7.20	1.61
	p value		0.58	0.48	0.64	0.67		0.14	0.41	0.37	0.57
65–74	**Odds Ratio**	1	0.63	0.69	0.47	0.82	1	1.84	1.65	0.19	0.85
	LCI		0.28	0.32	0.18	0.62		0.37	0.35	0.02	0.57
	UCI		1.43	1.48	1.24	1.10		9.17	7.69	1.95	1.27
	p value		0.27	0.35	0.13	0.19		0.46	0.52	0.16	0.43
75+	**Odds Ratio**	1	1.64	1.45	**0.11**	0.90	1	2.77	1.16		0.87
	LCI		0.50	0.41	0.01	0.60		0.53	0.10		0.50
	UCI		5.33	5.11	0.94	1.34		14.38	13.11		1.53
	p value		0.41	0.57	**0.04**	0.60		0.23	0.91		0.64

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p<0.05)

Table 7.10: Binary logistic regression of distance to alcohol outlets hazardous consumption by gender and specific age group (male 75+) while adjusting for a range of individual characteristics and contextual variables.

		National				
	Distance to alcohol outlets					
		<571m	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**
Baseline	**Odds Ratio**	1	1.64	1.45	**0.11**	0.90
	LCI		0.50	0.41	0.01	0.60
	UCI		5.33	5.11	0.94	1.34
	p value		0.41	0.57	**0.04**	0.60
Model 1	**Odds Ratio**	1	1.68	1.28	**0.11**	0.18
Personal income	**LCI**		0.51	0.37	0.01	1.29
	UCI		5.52	4.46	0.92	5.52
	p value		0.40	0.69	**0.04**	0.58
Model 2	**Odds Ratio**	1	1.79	1.41	**0.11**	0.89
Individual deprivation	**LCI**		0.51	0.39	0.01	0.60
	UCI		6.24	5.13	0.97	1.32
	p value		0.36	0.60	**0.05**	0.56
Model 3	**Odds Ratio**	1	1.87	1.40	0.07	0.89
Urban/Rural	**LCI**		0.55	0.39	0.00	0.52
	UCI		6.29	5.07	1.08	1.51
	p value		0.31	0.61	0.06	0.67
Model 4	**Odds Ratio**	1	1.89	1.20	**0.07**	0.84
Area Deprivation	**LCI**		0.56	0.27	0.00	0.48
	UCI		6.34	5.24	1.05	1.48
	p value		0.31	0.81	**0.05**	0.54

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Among older males aged 75 and over, hazardous consumption was influenced by distance as shown in Table 7.10. The analysis here could not control for ethnicity because of low numbers of other ethnic groups, but since this age group was predominantly European this was not a concern. After controlling for all other variables, it became apparent that older males living furthest away from outlets (>2.2 kilometres) were 93% less likely to consume alcohol hazardously when compared to those living closer to alcohol outlets (>571m), the reference group.

7.4.1.3 Hazardous consumption by ethnic group

Table 7.11 illustrates the national results for the European and Māori and Pacific Island ethnic groups. Europeans' hazardous consumption was not associated with distance from alcohol outlets, after controlling for a range of potential confounding variables. Significant relationships were only observed at baseline. There was no clear gradient and the test of trends was marginally insignificant ($p < 0.07$). Similarly, Māori and Pacific Island people's hazardous consumption had no association with distance after controlling for a range of confounding variables, except only at baseline as shown in Table 7.11. Results at baseline indicate that there was a negative association, since those residing near alcohol outlets were at higher odds of hazardous consumption compared to those living further away. The relationship, however, was weak because the second quartile distance (572–995 metres) was not significant. Most notably those living in the two furthest distance ranges (996 metres to 2.1 kilometres and greater than 2.2 kilometres) were 24% and 30% respectively, less likely to consume alcohol compared to those living closer to alcohol outlets (<571 metres), but only at baseline.

Table 7.11: Binary logistic regression of distance to alcohol outlets on hazardous consumption by ethnicity, while adjusting for a range of individual characteristics and contextual variables

		European					Māori and Pacific Island People				
		Distance to alcohol outlets									
		<571m	572–995m	996m–2.1km	>2.2km	Test of trends	<571m	572–995m	996m–2.1km	>2.2km	Test of trends
Baseline Model	**Odds Ratio**	1	1.03	1.00	**0.75**	0.93	1	0.87	**0.76**	**0.70**	0.88
	LCI		0.81	0.79	0.58	0.86		0.68	0.60	0.51	0.81
	UCI		1.31	1.26	0.96	1.00		1.12	0.96	0.96	0.97
	p value		0.84	0.97	**0.04**	0.07		0.29	**0.02**	**0.03**	**0.01**
Model 1 Age and Gender	**Odds Ratio**	1	1.13	1.02	0.84	0.95	1	0.88	0.82	0.78	0.87
	LCI		0.87	0.8	0.64	0.88		0.67	0.63	0.55	0.68
	UCI		1.46	1.31	1.10	1.04		1.15	1.06	1.09	1.12
	p value		0.39	0.80	0.25	0.26		0.34	0.13	0.15	0.29
Model 2 Personal income	**Odds Ratio**	1	1.13	1.04	0.85	0.96	1	0.95	0.89	0.84	0.94
	LCI		0.87	0.81	0.65	0.88		0.72	0.68	0.6	0.85
	UCI		1.47	1.34	1.12	1.04		1.25	1.16	1.19	1.04
	p value		0.35	0.71	0.31	0.32		0.71	0.39	0.33	0.26
Model 3 Individual deprivation	**Odds Ratio**	1	1.11	1.07	0.90	0.98	1	0.98	0.89	0.89	0.95
	LCI		0.85	0.84	0.69	0.90		0.74	0.68	0.63	0.86
	UCI		1.44	1.37	1.19	1.06		1.3	1.17	1.26	1.06
	p value		0.45	0.55	0.52	0.62		0.89	0.41	0.52	0.37
Model 4 Urban/rural	**Odds Ratio**	1	1.11	1.07	0.81	0.97	1	0.98	0.89	1.02	0.98
	LCI		0.85	0.84	0.57	0.89		0.74	0.68	0.67	0.87
	UCI		1.44	1.37	1.15	1.07		1.29	1.16	1.55	1.09
	p value		0.44	0.55	0.29	0.60		0.88	0.39	0.92	0.67
Model 5 Area Deprivation	**Odds Ratio**	1	1.13	1.07	0.81	0.97	1	1.01	0.94	1.16	1.01
	LCI		0.86	0.83	0.56	0.88		0.76	0.72	0.76	0.90
	UCI		1.47	1.38	1.17	1.08		1.35	1.24	1.78	1.14
	p value		0.39	0.58	0.32	0.62		0.93	0.67	0.49	0.84

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (P <0.05)

Since the ethnic group model was not significant nationally, and was mediated by gender and age, further analysis was performed for both genders and age. In order not to over adjust, the gender analysis was controlled only for age, urban/rural location and area deprivation (Table 7.12). Personal income and individual deprivation were not adjusted for (Kawachi and Berkman, 2003). Kawachi and Berkman (2003) suggested that health behaviour for genders is more a function of individual SES, and that adjusting for such variables therefore reduces explanatory power.

Table 7.12 illustrates the results for different genders. Consistent with previous analysis, there was a relationship for male Māori and Pacific Island people's hazardous consumption and distance, but only at baseline and only when adjusted for age, and not after controlling for all potential confounding variables. There was a statistically significant decline in the odds of hazardous consumption as distance increased, especially when comparing the nearest (<571 metres) and the furthest distance (>2.2 kilometres. Those living furthest away were 45% less likely to consume alcohol, compared to those living closest distance to alcohol outlets. When the analysis was adjusted for age (model one), the relationship between hazardous consumption and distance to alcohol outlets attenuated but remained significant. The test of trends also remained statistically significant. When the analysis was adjusted for urban and rural location (model two) and area deprivation (model three) the relationship between hazardous consumption and distance was no longer apparent.

For male European and female Māori and Pacific Island people there was no 'geography', see Table 7.12. The results illustrate that the odds of distance were not statistically significant and neither were the test of trends. For female Europeans, while the furthest distance was marginally not significant ($p < 0.06$) compared to the nearest distance, the test of trends was significant ($p < 0.01$), illustrating that a gradient existed, but the direction was not clear. The next step, therefore, was to identify the age group that mediated this relationship.

Table 7.12: Binary logistic regression of distance to alcohol outlets on hazardous consumption by ethnicity and gender, while adjusting for a range of individual characteristics and contextual variables.

		Male European					Male Māori and Pacific Island people					Female European					Female Māori and Pacific Island people				
		Distance to alcohol outlets																			
	Distance	<571 m	572–995 m	996m – 2.1km	>2.2k m	Test of trends	<571 m	572–995 m	996m – 2.1km	>2.2k m	Test of trends	<571 m	572–995 m	996m – 2.1km	>2.2k m	Test of trends	<571 m	572–995 m	996m – 2.1km	>2.2k m	Test of trends
Baseline	Odds Ratio	**1**	0.92	1.04	0.86	0.98	**1**	0.84	0.71	**0.55**	0.83	**1**	1.30	0.82	0.62	0.84	**1**	0.95	0.88	0.97	0.97
	LCI		0.69	0.79	0.63	0.89		0.58	0.5	0.36	0.73		0.85	0.54	0.37	0.73		0.67	0.62	0.61	0.85
	UCI		1.22	1.38	1.18	1.08		1.22	1.01	0.86	0.94		1.99	1.26	1.03	0.96		1.35	1.24	1.53	1.11
	p value		0.56	0.77	0.36	0.66		0.36	0.06	**0.01**	**0.01**		0.22	0.37	0.06	**0.01**		0.79	0.46	0.88	0.67
Model 1 Age	Odds Ratio	**1**	0.98	1.12	0.96	1.01	**1**	0.85	0.75	**0.61**	0.86	**1**	1.31	0.83	0.62	0.84	**1**	0.92	0.92	1.05	1.00
	LCI		0.73	0.84	0.69	0.91		0.58	0.51	0.39	0.74		0.85	0.53	0.37	0.72		0.64	0.64	0.65	0.87
	UCI		1.33	1.49	1.33	1.12		1.24	1.09	0.96	0.98		2.02	1.29	1.05	0.97		1.32	1.32	1.70	1.16
	p value		0.92	0.46	0.80	0.85		0.39	0.13	**0.03**	**0.03**		0.22	0.40	0.08	**0.02**		0.64	0.64	0.83	0.95
Model 2 Urban/rural	Odds Ratio	**1**	0.99	1.12	0.84	1.00	**1**	0.99	0.82	0.77	0.87	**1**	1.31	0.83	0.64	0.86	**1**	0.91	0.91	1.20	1.02
	LCI		0.73	0.84	0.56	0.89		0.66	0.56	0.43	0.74		0.85	0.53	0.32	0.72		0.63	0.63	0.70	0.88
	UCI		1.33	1.49	1.25	1.12		1.47	1.21	1.36	1.01		2.03	1.29	1.29	1.02		1.31	1.31	2.06	1.19
	p value		0.94	0.45	0.38	0.97		0.38	0.13	0.15	0.07		0.22	0.40	0.21	0.09		0.62	0.62	0.51	0.77
Model 3 Area deprivation	Odds Ratio	**1**	1.01	1.13	0.88	1.01	**1**	0.87	0.80	0.73	0.90	**1**	1.36	0.84	0.63	0.86	**1**	0.97	0.99	1.51	1.09
	LCI		0.74	0.84	0.58	0.90		0.59	0.54	0.41	0.77		0.87	0.53	0.31	0.72		0.68	0.69	0.88	0.93
	UCI		1.38	1.52	1.35	1.14		1.27	1.17	1.28	1.05		2.12	1.34	1.28	1.03		1.40	1.43	2.61	1.27
	p value		0.94	0.42	0.56	0.87		0.46	0.24	0.27	0.17		0.17	0.47	0.20	0.11		0.89	0.97	0.14	0.30

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations ($p < 0.05$)

7.4.1.4 Hazardous consumption by ethnicity, gender and age group

Gender analysis for the two ethnic groups illustrated that when adjusting for age, the relationship between hazardous consumption and distance attenuated, identifying age as a mediating factor. Further analysis was performed for all ethnic groups separated by gender and age to investigate which age group contributed most to this variance. A significant relationship was evident only in the case of younger people aged 15–24, as shown in Appendix 16. More analysis was therefore undertaken for this age group, while adjusting for all the other control variables.

Table 7.13 illustrates the results for all ethnic groups aged 15–24 by gender. Significant results were observed only in the Māori and Pacific Island males. The baseline model and model one illustrated that there was a strong and statistically significant decrease in the odds of hazardous consumption as the distance to alcohol outlets increased. Furthermore, the test of trends was also significant ($p < 0.01$), showing that there was a gradient indicating a negative association where, as hazardous consumption decreased, distance increased. The association between the shortest and the furthest distance was still statistically significant even when individual deprivation was adjusted for (Model 2). The odds for differences between the shortest and furthest distance decreased. Whereas those in the furthest distance were 70% less likely to consume alcohol at baseline after adjusting for personal income; this association decreased to 66% when the analysis was adjusted for individual deprivation.

After adjusting for urban/rural location while the test of trends was significant, the association between the reference group and the longest distance was marginally insignificant (model three). Urban/rural location therefore mediates the relationship between distance and hazardous consumption amongst younger (15–24 year old) Māori and Pacific Island people. When the final control, area deprivation, was added, the results were strong and statistically significant (model four). In addition, the third quartile distance (996 metres to 2.1 kilometres) was not significant when the analysis adjusted for personal income but individual deprivation was now strong and statistically significant ($p < 0.05$). Those living in the third quartile and those living the furthest away (more than 2.2 kilometres) were 58% and 73% respectively, less likely to be hazardous consumers, both compared to the reference group (<571 metres).

Table 7.13: Binary logistic regression of distance to alcohol outlets hazardous consumption by ethnicity, gender and specific age group (15–24years) while adjusting for a range of individual characteristics and contextual variables.

		Male European					Male Māori and Pacific Island people					Female European					Female Māori and Pacific Island people				
		Distance to alcohol outlets																			
	Distance	<571m	572–995m	996m–2.1km	>2.2km	Test of trends	<571m	572–995m	996m–2.1km	>2.2km	Test of trends	<571m	572–995m	996m–2.1km	>2.2km	Test of trends	<571m	572–995m	996m–2.1km	>2.2km	Test of trends
Baseline	Odds Ratio	**1**	1.09	1.26	0.85	1.09	**1**	0.76	0.52	**0.30**	0.68	**1**	1.99	0.63	0.61	0.76	**1**	1.07	1.02	1.11	1.02
	LCI		0.50	0.58	0.36	0.82		0.34	0.24	0.11	0.50		0.87	0.26	0.20	0.56		0.58	0.55	0.52	0.81
	UCI		2.37	2.73	1.99	1.46		1.67	1.13	0.85	0.92		4.56	1.55	1.81	1.03		1.98	1.89	2.39	1.28
	p value		0.83	0.56	0.70	0.54		0.49	0.10	**0.02**	**0.01**		0.10	0.32	0.37	0.08		0.82	0.96	0.78	0.87
Model 1 Personal income	Odds Ratio	**1**	1.43	1.75	1.07	1.09	**1**	0.76	0.66	**0.30**	0.71	**1**	1.72	0.56	0.54	0.74	**1**	1.12	1.12	1.17	1.05
	LCI		0.62	0.76	0.42	0.82		0.32	0.30	0.12	0.53		0.73	0.22	0.17	0.54		0.59	0.58	0.54	0.83
	UCI		3.31	4.05	2.72	1.46		1.80	1.45	0.79	0.96		4.06	1.38	1.71	1.02		2.13	2.13	2.54	1.32
	p value		0.41	0.19	0.88	0.54		0.54	0.30	**0.02**	**0.03**		0.22	0.21	0.30	0.06		0.72	0.74	0.68	0.69
Model 2 Individual deprivation	Odds Ratio	**1**	1.15	1.96	1.23	1.17	**1**	0.73	0.52	**0.34**	0.70	**1**	1.41	0.55	0.62	0.77	**1**	1.03	1.13	1.17	1.06
	LCI		0.46	0.79	0.45	0.86		0.30	0.24	0.13	0.53		0.57	0.21	0.20	0.55		0.53	0.56	0.55	0.84
	UCI		2.82	4.90	3.34	1.60		1.79	1.14	0.85	0.93		3.45	1.46	1.92	1.08		2.02	2.25	2.49	1.34
	p value		0.77	0.15	0.68	0.32		0.49	0.10	**0.02**	**0.02**		0.46	0.23	0.40	0.13		0.93	0.73	0.69	0.63
Model 3 Urban/rural	Odds Ratio	**1**	1.16	1.97	1.50	1.29	**1**	0.73	0.51	0.38	0.72	**1**	1.37	0.54	0.89	0.82	**1**	1.02	1.11	1.58	1.12
	LCI		0.47	0.79	0.42	0.89		0.30	0.24	0.13	0.53		0.55	0.20	0.22	0.55		0.52	0.56	0.63	0.86
	UCI		2.88	4.90	5.38	1.88		1.79	1.13	1.15	0.98		3.39	1.43	3.57	1.21		1.99	2.22	3.92	1.45
	p value		0.75	0.15	0.53	0.18		0.49	0.10	0.09	**0.04**		0.49	0.21	0.86	0.32		0.96	0.76	0.33	0.40
Model 4 Area deprivation	Odds Ratio	**1**	0.97	1.89	1.67	1.31	**1**	0.75	**0.42**	**0.27**	0.64	**1**	1.39	0.54	0.79	0.81	**1**	1.00	1.14	1.83	1.16
	LCI		0.37	0.67	0.45	0.86		0.29	0.18	0.08	0.45		0.57	0.20	0.18	0.54		0.51	0.57	0.70	0.88
	UCI		2.52	5.35	6.26	1.98		1.94	0.98	0.90	0.91		3.43	1.47	3.45	1.21		1.98	2.26	4.76	1.51
	p value		0.94	0.23	0.45	0.20		0.55	**0.05**	**0.03**	**0.01**		0.47	0.23	0.76	0.30		0.99	0.71	0.22	0.29

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

The test of trends was also statistically significant (p <0.01) and illustrated that there was a gradient with those living closer to outlets having higher odds of hazardous consumption than those living further away, even after controlling for deprivation. Appendix 14 shows that over 40% male and female Māori and Pacific Island people live in deprived areas (NZHS 2006/07). There was no statistically significant association between distance to alcohol outlets and the hazardous consumption of younger male and female Europeans or female Māori and Pacific Island people. Other age groups >25 years did not present any significant estimates for all ethnic groups, stratified by gender and ethnicity.

In summary, these results show that after controlling for a range of confounding variables, younger Māori and Pacific Island males aged 15–24 were at higher odds of consuming alcohol hazardously if they were living closer to alcohol outlets (less than 571 meters) compared to those living further away (distances greater than 996 metres). This group has the highest hazardous consumption rates in New Zealand and alcohol outlets within closer proximity appear to have a significant influence on their drinking behaviour.

7.4.1.5 Hazardous consumption in urban/rural areas

In urban and rural areas, there was no statistically significant relationship between hazardous consumption and distance. Appendix 17 illustrates that there was no ‘geography’ of alcohol consumption in urban areas and rural areas, even before adjustment. The urban baseline model shows that the result was marginally out of the 95% confidence interval. In addition, the test of trends was not significant.

More analysis was performed for the different genders. At urban locations, there was no significant relationship between males’ and females’ hazardous alcohol consumption and distance (Appendix 18). In contrast, at rural locations, while there was an association, the relationship between males’ and females’ hazardous consumption and distance were in different directions. Results for rural males indicate a positive association: as hazardous consumption *increased;* distance *increased.* For females the negative association of decreased hazardous alcohol consumption was found. This result was consistent from baseline and still held even after adjusting for potential confounding variables. For example, rural males at baseline, before adjusting for any confounding variable, living in the third quartile distance (996 metres to 2.1 kilometres) were three times more likely to consume hazardously than those living closer to alcohol outlets. For females on the other hand, those living within the same distance were 80% less likely to consume hazardously. Sixty-two percent of those furthest from alcohol outlets (greater than 2.2 kilometres) were less likely to consume alcohol hazardously when they were compared to the reference group (<571 metres), before adjusting for any confounding variable.

After adjusting for age, the OR for males increased by 38%, and those living in the third quartile distance (between 996 metres to 2.1 kilometres) were four times more likely to consume hazardously, while for females within the same distance the ORs attenuated showing that 82% were less likely to consume hazardously when compared to the reference group. The test of trends was significant for females and not males, since the male results show no clear gradient. The ORs changed marginally after adjusting for ethnicity, but increased for males and reduced for females when controlled for personal income. The change was minimal for both males and females when adjusted for individual and area level deprivation; however, for females the furthest distance was no longer significant when adjusted for all SES variables, showing that consumption was mediated by SES variables rather than distance. The test of trends was also not significant. These results show that the 'geography' for hazardous consumption for men in rural areas was in the opposite positive direction, and the expected negative direction for rural women living in the third quartile distances (between 996 metres to 2.1 kilometres). Chapter 6 had shown that even though the median distances in rural areas were slightly longer, there was still a social gradient. Interestingly, females living closer to alcohol outlets in rural areas were more likely to consume hazardously, a result that did not reach significance for their urban counterparts.

An analysis of age groups in urban and rural areas exhibited no significant associations between hazardous consumption and distance (Appendix 19). The lack of significance of this relationship was due to the fact that all the urban areas were grouped together. This grouping masks associations in specific urban areas where hazardous consumption and alcohol outlets are concentrated. An improved analysis strategy would have separated the different urban areas and investigated for differences;

however, because of the ethical confidentiality issues related to the data such analysis could not be undertaken. The next section examines the second measure of alcohol-related behaviour, frequent consumption of five or more drinks on one occasion

7.4.2 Frequent consumption of five or more drinks

Further analysis was performed for those who consume frequently (five or more drinks on one occasion whether monthly, weekly or daily) compared to those who do not. A criterion for the selection of variables was highlighted in Chapter 4. As with other analysis, abstainers were excluded. All the analysis models were run at national or urban/rural level stratified by gender, age group and ethnicity.

7.4.2.1 Frequent consumption of five or more drinks nationally

Nationally, there was no association between frequent consumption and distance after controlling for all confounding variables as shown in Table 7.14. After controlling for urban/rural location, the results showed a statistically significant negative association with people living 2.2 kilometres away; they were 25% less likely to consume alcohol frequently than others living closer to alcohol outlets. When the analysis was adjusted for area deprivation, the relationship disappeared.

Table 7.14: Binary logistic regression of national distance to alcohol outlets on frequent consumption of five or more alcoholic drinks while adjusting for a range of individual characteristics and contextual variables.

				National		
			Distance to alcohol outlets			
	Distance	**<571m**	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**
Baseline	**Odds Ratio**	1	0.93	0.98	**0.80**	0.95
	LCI		0.78	0.83	0.66	0.90
	UCI		1.10	1.16	0.97	1.01
	p value		0.39	0.80	**0.02**	0.08
Model 1 Age and Gender	**Odds Ratio**	1	0.97	1.01	0.89	0.95
	LCI		0.80	0.85	0.73	0.90
	UCI		1.18	1.21	1.09	1.01
	p value		0.79	0.89	0.27	0.08
Model 2 Ethnicity	**Odds Ratio**	1	0.97	1.00	0.86	0.96
	LCI		0.80	0.83	0.70	0.91
	UCI		1.18	1.19	1.05	1.03
	p value		0.77	0.98	0.15	0.27
Model 3 Personal income	**Odds Ratio**	1	0.95	0.99	0.88	0.97
	LCI		0.78	0.83	0.72	0.91
	UCI		1.16	1.19	1.09	1.04
	p value		0.63	0.95	0.24	0.40
Model 4 Individual deprivation	**Odds Ratio**	1	0.95	1.00	0.91	0.98
	LCI		0.78	0.83	0.74	0.92
	UCI		1.16	1.21	1.11	1.05
	p value		0.62	0.97	0.35	0.56
Model 5 Urban/Rural	**Odds Ratio**	1	0.95	1.01	**0.75**	0.95
	LCI		0.78	0.84	0.58	0.89
	UCI		1.16	1.21	0.98	1.02
	p value		0.64	0.96	**0.04**	0.19
Model 6 Area Deprivation	**Odds Ratio**	1	0.98	1.04	0.80	0.97
	LCI		0.80	0.86	0.61	0.90
	UCI		1.20	1.25	1.05	1.05
	p value		0.85	0.70	0.11	0.44

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

7.4.2.2 Frequent consumption of five or more drinks by sub-populations: gender and age

Nationally, there was no statistically significant association of males and females for frequent consumption and distance (Appendix 20). Further analysis undertaken for males and females stratified by age group, identified women aged 35–44 and middle aged men (45–54) men for further investigation (Appendix 21). For comparative purposes, men and women of both identified ages were examined.

Males and females aged 35–44 had no geography of consumption after potential confounding variables were controlled (Appendix 22). Similar analysis was undertaken for middle aged men and women (45–54). Frequent consumption among middle aged men (45–54) proved to have an association with distance after potential confounding variables had been controlled for. Middle aged men living closer to alcohol outlets (<571m) had higher odds of consumption than those living in the next nearest quartile (572–996 metres), who were 50% less likely to consume five or more drinks frequently (Appendix 22). In summary, there was a statistically significant decline in the odds of middle aged men being frequent consumers as distance increased, indicating a negative association, but the same was not true for females of the same age.

7.4.2.3 Frequent consumption of five or more drinks by ethnicity

Further analysis was undertaken to identify ethnic differences in the consumption of five or more drinks frequently. Table 7.15 illustrates that after controlling for a range of potential confounding variables, there was a negative association of European frequent consumers and distance; however, the results for Māori and Pacific Island people were not significant. Both Europeans and Māori and Pacific Island people had significant results at baseline; nonetheless, this relationship was no longer apparent after adjusting for age, gender and (two) socio-economic status measures. Europeans exhibited significant results when urban/rural location and area deprivation were controlled for, illustrating that when all variables were adjusted for, there was negative association in the expected direction.

Table 7.15: Binary logistic regression of distance to alcohol outlets on frequent consumption of five or more alcoholic drinks by ethnicity after adjusting for potential confounding variables.

		European					Māori and Pacific Island People				
		Distance to alcohol outlets									
		<571m	572–995m	996m–2.1km	>2.2km	Test of trends	<571m	572–995m	996m–2.1km	>2.2km	Test of trends
Baseline Model	**Odds Ratio**	1	0.93	1.08	**0.80**	0.96	1	0.95	**0.73**	0.83	0.91
	LCI		0.76	0.88	0.63	0.90		0.73	0.58	0.60	0.82
	UCI		1.15	1.32	1.00	1.03		1.22	0.93	1.15	1.00
	p value		0.53	0.48	**0.05**	0.25		0.67	**0.01**	0.26	**0.04**
Model 1 age and Gender	**Odds Ratio**	1	0.99	1.09	0.86	0.98	1	0.96	0.78	0.91	0.94
	LCI		0.79	0.87	0.67	0.90		0.73	0.61	0.64	0.85
	UCI		1.26	1.35	1.10	1.05		1.25	1.01	1.29	1.04
	p value		0.97	0.46	0.23	0.51		0.74	0.06	0.60	0.21
Model 2 Personal income	**Odds Ratio**	1	0.95	1.06	0.87	0.98	1	1.03	0.84	1.02	0.97
	LCI		0.75	0.85	0.68	0.91		0.79	0.65	0.72	0.87
	UCI		1.21	1.33	1.11	1.06		1.36	1.09	1.46	1.08
	p value		0.70	0.60	0.27	0.58		0.82	0.20	0.90	0.57
Model 3 Individual deprivation	**Odds Ratio**	1	0.94	1.07	0.89	0.99	1	1.05	0.85	1.06	0.98
	LCI		0.74	0.86	0.69	0.91		0.80	0.66	0.74	0.88
	UCI		1.20	1.34	1.14	1.07		1.39	1.10	1.51	1.08
	p value		0.63	0.55	0.35	0.73		0.70	0.21	0.76	0.66
Model 4 Urban/rural	**Odds Ratio**	1	0.95	1.07	**0.67**	0.95	1	1.05	0.85	1.14	0.98
	LCI		0.75	0.86	0.49	0.87		0.80	0.65	0.75	0.87
	UCI		1.20	1.34	0.93	1.04		1.38	1.10	1.73	1.09
	p value		0.66	0.54	**0.02**	0.24		0.71	0.21	0.54	0.70
Model 5 Area Deprivation	**Odds Ratio**	1	0.97	1.09	**0.71**	0.96	1	1.08	0.89	1.24	1.01
	LCI		0.76	0.87	0.51	0.88		0.82	0.68	0.80	0.89
	UCI		1.24	1.38	0.98	1.05		1.43	1.17	1.93	1.13
	p value		0.79	0.45	**0.04**	0.40		0.59	0.41	0.34	0.93

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

The results for gender show that there was no relationship between frequent consumption and distance for Europeans of either gender, or for female Māori and Pacific Island people (Table 7.16). Male Māori and Pacific Island people do, however, demonstrate a statistically significant decline in the odds of frequent consumption for those living between 996 metres and 2.1 kilometres away from an alcohol outlet compared to those living within the closest distance (<571 metres). At baseline male Māori and Pacific Island people living within that distance were 35% less likely to consume alcohol frequently compared to the reference group. The ORs increased marginally when the analysis was adjusted for age, urban/rural location and area deprivation, but were still statistically significant.

Table 7.16: Binary logistic regression of distance to alcohol outlets and control variables on frequent consumption of five or more alcoholic drinks by ethnicity and gender while adjusting for a range of individual characteristics and contextual variables.

·		Male European					Male Māori and Pacific Island people					Female European					Female Māori and Pacific Island people				
		Distance to alcohol outlets																			
	Distance	**<571m**	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**
Baseline	**Odds Ratio**	1	0.88	1.05	0.89	0.99	1	0.83	**0.65**	0.71	0.86	1	1.07	1.03	0.67	0.90	1	1.14	0.89	1.04	0.97
	LCI		0.68	0.81	0.67	0.91		0.57	0.46	0.45	0.76		0.74	0.72	0.44	0.80		0.82	0.63	0.65	0.85
	UCI		1.15	1.35	1.19	1.08		1.22	0.91	1.10	0.98		1.54	1.45	1.02	1.01		1.60	1.25	1.64	1.11
	p value		0.36	0.71	0.44	0.86		0.35	**0.01**	0.13	**0.03**		0.74	0.89	0.06	0.09		0.43	0.48	0.88	0.67
Model 1	**Odds Ratio**	1	0.93	1.10	0.96	1.01	1	0.83	**0.69**	0.77	0.89	1	1.07	1.03	0.67	0.90	1	1.11	0.91	1.10	0.99
Age	**LCI**		0.71	0.84	0.71	0.92		0.57	0.48	0.48	0.77		0.72	0.72	0.43	0.79		0.79	0.64	0.68	0.86
	UCI		1.22	1.43	1.29	1.11		1.22	0.97	1.23	1.02		1.59	1.49	1.03	1.02		1.57	1.30	1.79	1.15
	p value		0.60	0.48	0.78	0.79		0.35	**0.03**	0.27	**0.09**		0.73	0.86	0.07	0.10		0.55	0.60	0.69	0.93
Model 2	**Odds Ratio**	1	0.94	1.10	0.72	0.97	1	0.83	**0.68**	0.86	0.89	1	1.07	1.03	0.54	0.89	1	1.11	0.91	1.09	0.98
Urban/rural	**LCI**		0.71	0.85	0.50	0.88		0.57	0.48	0.51	0.77		0.73	0.72	0.29	0.76		0.79	0.64	0.62	0.85
	UCI		1.23	1.43	1.04	1.08		1.22	0.97	1.44	1.03		1.58	1.49	1.02	1.04		1.58	1.30	1.93	1.15
	p value		0.64	0.47	0.08	0.59		0.34	**0.03**	0.56	0.11		0.73	0.87	0.06	0.15		0.54	0.61	0.76	0.84
Model 3	**Odds Ratio**	1	0.96	1.10	0.75	0.98	1	0.85	**0.70**	0.89	0.90	1	1.09	1.11	0.60	0.92	1	1.17	0.99	1.29	1.04
Area deprivation	**LCI**		0.73	0.84	0.51	0.88		0.58	0.49	0.52	0.78		0.74	0.76	0.31	0.78		0.83	0.69	0.72	0.88
	UCI		1.27	1.44	1.10	1.09		1.25	1.00	1.54	1.05		1.61	1.61	1.14	1.09		1.66	1.44	2.34	1.22
	p value		0.79	0.49	0.14	0.67		0.40	**0.05**	0.68	0.17		0.66	0.60	0.12	0.35		0.36	0.98	0.39	0.66

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

More analysis was undertaken to identify which age groups contribute to these differences observed in different genders. Significant relationships were observed in European females aged 35–44, and in older Māori and Pacific Island males aged 65–74 (Appendix 23). The two identified age groups were subjected to further regression analysis to examine whether the ‘geography’ remained after controlling for a variety of confounding variables.

Table 7.17 illustrates that after controlling for all potential confounding variables, there was no association between European and Māori and Pacific Island females aged 35–44 and frequent consumption and distance (Table 7.17). Likewise, an analysis of older people (65–74) also showed no significant relationship (Table 7.18).

Table 7.17: Binary logistic regression of distance to alcohol outlets on frequent consumption of five or more alcoholic drinks, by ethnicity, gender and a specific age group (35–44), while adjusting for a range of individual characteristics and contextual variables

		European Females 35–44					**Females Māori and Pacific Island people 35–44**				
		Distance to alcohol outlets									
	Distance	**<571m**	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**
Baseline	**Odds Ratio**	1	0.65	0.77	**0.28**	0.74	1	**0.46**	0.57	0.62	0.89
	LCI		0.32	0.40	0.12	0.59		0.23	0.28	0.25	0.66
	UCI		1.32	1.49	0.66	0.93		0.94	1.17	1.57	1.19
	p value		0.24	0.44	**0.00**	**0.01**		**0.03**	0.13	0.32	0.42
Model 1	**Odds Ratio**	1	0.62	0.74	**0.29**	0.74	1	**0.48**	0.55	0.70	0.91
Personal	**LCI**		0.30	0.38	0.12	0.59		0.23	0.25	0.27	0.67
income	**UCI**		1.25	1.44	0.67	0.94		1.01	1.18	1.78	1.23
	p value		0.18	0.37	**0.00**	**0.01**		**0.05**	0.12	0.45	0.53
Model 2	**Odds Ratio**	1	0.65	0.80	**0.32**	0.77	1	0.49	0.60	0.74	0.94
Individual	**LCI**		0.32	0.40	**0.13**	0.60		0.23	0.28	0.30	0.70
deprivation	**UCI**		1.32	1.59	0.77	0.98		1.03	1.26	1.84	1.27
	p value		0.24	0.52	**0.01**	**0.04**		0.06	0.18	0.52	0.69
Model 3	**Odds Ratio**	1	0.65	0.80	**0.29**	0.78	1	0.49	0.60	0.72	0.91
Urban/rural	**LCI**		0.32	0.40	0.10	0.59		0.23	0.28	0.26	0.67
	UCI		1.33	1.58	0.83	1.03		1.03	1.27	1.99	1.24
	p value		0.24	0.52	**0.02**	0.08		0.06	0.18	0.52	0.56
Model 4	**Odds Ratio**	1	0.71	0.92	0.36	0.84	1	0.49	0.61	0.82	0.94
Area	**LCI**		0.35	0.46	0.11	0.62		0.23	0.29	0.28	0.68
deprivation	**UCI**		1.44	1.83	1.14	1.15		1.05	1.32	2.39	1.30
	p value		0.34	0.80	0.08	0.27		0.07	0.21	0.72	0.72

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p <0.05)

Table 7.18: Binary logistic regression of distance to alcohol outlets on frequent consumption of five or more alcoholic drinks by ethnicity, gender and a specific age group (65–74) while adjusting for a range of individual characteristics and contextual variables

		European Males 75+					Male Māori and Pacific Island people 75+				
		Distance to alcohol outlets									
	Distance	**<571m**	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572–995m**	**996m–2.1km**	**>2.2km**	**Test of trends**
Baseline	**Odds Ratio**	1	0.76	0.76	0.84	0.95	1	**0.18**	0.62	0.77	0.84
	LCI		0.34	0.35	0.37	0.73		0.04	0.11	0.09	0.37
	UCI		1.71	1.63	1.93	1.25		0.87	3.42	6.80	1.90
	p value		0.51	0.48	0.68	0.73		**0.03**	0.58	0.81	0.68
Model 1	**Odds Ratio**	1	0.64	0.65	0.74	0.92	1	**0.13**	0.53	0.70	0.80
Personal income	**LCI**		0.28	0.30	0.32	0.70		0.02	0.08	0.05	0.31
	UCI		1.44	1.43	1.74	1.22		0.81	3.46	9.76	2.06
	p value		0.28	0.28	0.49	0.58		**0.03**	0.51	0.79	0.65
Model 2	**Odds Ratio**	1	0.69	0.71	0.83	0.96	1	0.28	1.50	2.42	1.40
Individual deprivation	**LCI**		0.29	0.32	0.35	0.72		0.07	0.26	0.22	0.66
	UCI		1.61	1.59	2.00	1.27		1.13	8.58	26.39	2.98
	p value		0.39	0.41	0.68	0.77		0.07	0.65	0.47	0.39
Model 3	**Odds Ratio**	1	0.68	0.71	0.72	0.91	1	0.28	1.73	6.13	1.58
Urban/rural	**LCI**		0.29	0.32	0.28	0.67		0.06	0.30	0.56	0.70
	UCI		1.60	1.58	1.84	1.22		1.18	9.93	67.27	3.56
	p value		0.38	0.40	0.49	0.52		0.08	0.54	0.14	0.27
Model 4	**Odds Ratio**	1	0.78	0.73	0.88	0.93	1	0.47	3.59	10.79	2.17
area deprivation	**LCI**		0.34	0.33	0.33	0.68		0.07	0.40	0.89	0.88
	UCI		1.76	1.65	2.33	1.27		3.20	31.93	130.54	5.34
	p value		0.55	0.45	0.80	0.66		0.44	0.25	0.06	0.09

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

7.4.2.4 Frequent consumption by urban and rural location

An analysis of urban/rural locations indicated contrasting results in that in both urban and rural areas, there was no association between frequent consumption and distance; however, the tests of trends were significant, even though the relationships between the distances were marginally insignificant. In summary, there was no 'geography' of frequent consumption in urban or rural areas (Appendix 24). Additional analysis was therefore performed for both males and females in both locations to identify which of the two genders contributes to the significant test of trends.

In urban areas, there were no significant associations between males and females who were frequent consumers and the distance from alcohol outlets (Appendix 25). In rural areas, there were significant results for both males and females but in different directions. The rural male rates were in the opposite direction from that expected;

those living further from alcohol outlets had higher odds of frequent consumption than those living closer. On the contrary for rural women, those living further away were less likely to consume alcohol frequently than those living near outlets. These results partly explain why the test of trends for gender was significant, but not the test for distance. At baseline, rural females living furthest away (>2.2 kilometres) were 67% less likely to consume frequently compared to those living closer to outlets. Rural females living furthest away (>2.2 kilometres) from alcohol outlets were 76% were less likely to consume alcohol frequently, after controlling for age. These differences remained between 73% and 76% when all the other control variables were added, showing that rural females living furthest away (>2.2 kilometres) were less likely to consume frequently compared to those living closer to outlets. By comparison, rural men who live 996 metres to 2.1 kilometres away from an outlet had three times higher odds of consumption compared to those living closer by (<571 metres). In short, after controlling for all potential cofounding variables, there was a strong negative association of rural women's frequent consumption and distance, but the reverse was true for rural men.

7.4.3 Summary

The analysis for all New Zealand shows that there was no 'geography', measured by distance to alcohol outlets, for the two measures of alcohol-related behaviour, hazardous and frequent consumption. These results were consistent even when potential confounding variables were taken into account. The results do show some statistically significant decline in the odds of alcohol-related behaviour for some sub-populations with increasing distance to alcohol outlets (Table 7.19). The association between hazardous consumption and distance was particularly strong for younger Māori and Pacific Island males aged 15–24 and older males of all ethnic groups aged 75 and over. Rural males had significant, but unexpected, results: as consumption *increased;* distance *increased.* In contrast the results for females ran in the reverse (expected) direction. For frequent consumption, a statistically significant decline in ORs was evident in middle aged 45–54 year old males as distance increased; this was also true for Europeans, male Māori and Pacific Island people, and rural women. While these relationships were interesting, it is worth noting that almost 65% of frequent consumers were also hazardous consumers, therefore, the analysis was dealing with almost similar groups of people.

Table 7.19: Summary table of significant results

		Alcohol-related behaviour	
Access	**Sub-groups**	**Hazardous consumption**	**Frequent consumption**
Distance measures	Population	(n=9980) 0 = Non-Haz 1= Haz	(n=10,012) 0 = Non Freq 5 1 = Freq 5
Nearest distance to alcohol outlet 1 = 0–-571m 2 = 572m–995m 3 = 996–2160m 4 = >2161m	**National**		
	Population as a whole	Not significant	Not significant
	Sub-Population		
	Age and Gender	+ 75+ Males	+ Middle aged 45–54 men
	Ethnicity, age and gender	+ 15–24 Male Māori and Pacific Island people	+ Europeans + Male Māori and Pacific Island people
	Rural urban		
	Whole Population		
	Age and gender	+ Rural women – Rural Men	+ Rural women – Rural men

+ Relationship in expected direction, negative association as distance increase consumption reduces

- Relationship in opposite direction; as distance *increased* consumption *increased*

Non-Haz = Non-hazardous consumption, AUDIT score less than 8.

Haz = Hazardous consumption, AUDIT score of 8 or more.

Non- Freq 5 = consuming 5 drinks or more (on one occasion) less than once a month or never

Freq 5 = consuming 5 drinks or more (on one occasion) monthly, weekly or daily.

The next step in the analysis examined the relationship of alcohol-related behaviour and density of alcohol outlets, measured by the number of alcohol outlets within buffers of 800 metres, also referred to as walking distance.

7.5 Influence of density

The previous section of this chapter examined relationships between distance to alcohol outlets and alcohol-related behaviour. This section examines density measures of 800 and 3000 metre buffers. According to Pearce et al., (2008a), few studies internationally have used buffers; however, they are important because the sphere of influence of each outlet often extends beyond the meshblock boundary. People do not necessarily visit alcohol outlets within their meshblock area boundaries, they can choose where to go whether on foot or in cars. To this end, the density of alcohol outlets within 800 metres and 3000 metres from population weighted centroids in meshblocks were calculated in ArcGIS as described in Chapter 4.

7.6 Buffers of 800 metres

The first measure used in this second section of the analysis is a buffer of 800 metres, which has been denoted as the walking distance to the nearest alcohol outlet (Donkin et al., 2000, Pearce et al., 2008a). The density of alcohol outlets within 800 metres were calculated and classified into four categories including: neighbourhoods with no outlets, one to two outlets, three to six outlets and over seven outlets (Table 7.1). The assumption made was that there is a positive association where odds of both hazardous and frequent consumption *increase* with *increases* in number of outlets within walking distance (a radius of 800 metres). All the steps taken above in the analysis for distance were repeated for buffers of 800 metres starting with the national level (Table 7.1).

7.6.1 Hazardous consumption

7.6.1.1 Hazardous consumption nationally

After controlling for potential confounding variables, there was no association at the national level, between hazardous consumption and the density of outlets within an 800 metre buffer. As with earlier results, significant results were only observed at the baseline. There was a positive and statistically significant increase in the odds of hazardous consumption with an increase in the number of outlets within the 800 metre buffer (or walking distance). The odds of hazardous consumption were 1.3 (CI 1.02–1.59) times higher in neighbourhoods that had seven or more outlets when compared to the reference group of no outlets (Table 7.20). When age and gender, ethnicity, personal income, individual deprivation, urban/rural location and area deprivation were adjusted for, the ORs attenuated, hence there was no significant result.

Table 7.20: Binary logistic regression of the density of alcohol outlets within an 800 metre buffer, and control variables on hazardous consumption of alcohol while adjusting for a range of individual characteristics and contextual variables.

		National				
		Density of alcohol outlets within an 800 metre buffer				
	Distance	**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.10	1.07	**1.27**	1.07
	LCI		0.93	0.89	1.02	1.00
	UCI		1.30	1.28	1.59	1.14
	p value		0.28	0.49	**0.03**	**0.05**
Model 1	**Odds Ratio**	1	1.05	0.97	1.12	1.02
Age and Gender	**LCI**		0.87	0.80	0.89	0.96
	UCI		1.25	1.18	1.41	1.09
	p value		0.62	0.79	0.32	0.52
Model 2	**Odds Ratio**	1	1.08	0.99	1.21	1.04
Ethnicity	**LCI**		0.90	0.81	0.96	0.97
	UCI		1.29	1.20	1.53	1.12
	p value		0.41	0.91	0.10	0.23
Model 3	**Odds Ratio**	1	1.09	1.00	1.19	1.04
Personal income	**LCI**		0.90	0.82	0.94	0.97
	UCI		1.31	1.21	1.51	1.11
	p value		0.38	0.97	0.15	0.28
Model 4	**Odds Ratio**	1	1.07	0.96	1.12	1.02
Individual deprivation	**LCI**		0.89	0.79	0.89	0.95
	UCI		1.29	1.17	1.41	1.09
	p value		0.46	0.71	0.33	0.58
Model 5	**Odds Ratio**	1	1.07	0.96	1.12	1.02
Urban/Rural	**LCI**		0.88	0.78	0.88	0.95
	UCI		1.31	1.19	1.42	1.10
	p value		0.49	0.73	0.35	0.61
Model 6	**Odds Ratio**	1	1.07	0.95	1.10	1.01
Area Deprivation	**LCI**		0.88	0.77	0.86	0.94
	UCI		1.31	1.18	1.40	1.09
	p value		0.49	0.65	0.45	0.77

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

7.6.1.2 Hazardous consumption by sub-population: Gender and Age

Further analysis was undertaken for both genders (Appendix 26). There was no statistically significant association for either male or female hazardous consumption with the density of alcohol outlets within an 800 metre buffer after controlling for all confounding variables. However, females presented interesting results which were all significant and which disappeared only when the final control variable, area deprivation was added. At baseline, females living in areas with seven or more outlets had two times higher odds (OR 1.82: CI 1.25–2.65) of hazardous consumption compared to those who live in areas with no outlets within a radius of 800 metres. After adjusting for age, personal income, individual deprivation and urban/rural location, the odds for those living in outlets with seven or more outlets attenuated, but were still statistically significant. The tests of trends were also significant indicating a positive association between females' odds of hazardous consumption and the density of alcohol outlets, except when the analysis was adjusted for area deprivation.

More analysis was undertaken for all age groups to identify the age group most influenced by the density of alcohol outlets (Appendix 27). This analysis was unadjusted and showed that younger females living in areas with seven or more alcohol outlets within walking distance had 2.6 (CI 1.40–4.82) higher odds of hazardous consumption compared to females of a similar age who live in areas with no outlets. All other age groups by gender presented no significant results except for males aged 25–34, but their odds were in the opposite, negative, direction.

Table 7.21: Binary logistic regression of density of alcohol outlets within an 800 metre buffer on hazardous consumption of alcohol for younger females aged 15–24 while adjusting for a range of individual characteristics and contextual variables

		15–24 years				
		Density of alcohol outlets within 800 metres buffer				
		No outlet	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.40	1.04	**2.60**	1.29
	LCI		0.82	0.59	1.40	1.05
	UCI		2.41	1.84	4.81	1.58
	p value		0.22	0.88	**0.00**	**0.01**
Model 1	**Odds Ratio**	1	1.50	1.03	**3.19**	1.35
Ethnicity	**LCI**		0.86	0.58	1.63	1.09
	UCI		2.63	1.84	6.26	1.67
	p value		0.16	0.91	**0.00**	**0.01**
Model 2	**Odds Ratio**	1	1.47	1.12	**3.21**	1.37
Personal income	**LCI**		0.82	0.63	1.60	1.09
	UCI		2.65	2.00	6.46	1.71
	p value		0.20	0.70	**0.00**	**0.01**
Model 3	**Odds Ratio**	1	1.44	1.01	**2.52**	1.26
Individual deprivation	**LCI**		0.79	0.54	1.29	1.02
	UCI		2.61	1.89	4.91	1.56
	p value		0.24	0.98	**0.01**	**0.03**
Model 4	**Odds Ratio**	1	1.28	0.89	**2.22**	1.22
Urban/Rural	**LCI**		0.67	0.46	1.11	0.97
	UCI		2.44	1.71	4.45	1.52
	p value		0.45	0.73	**0.03**	0.09
Model 5	**Odds Ratio**	1	1.28	0.90	**2.34**	1.22
Area Deprivation	**LCI**		0.67	0.47	1.17	0.98
	UCI		2.44	1.73	4.67	1.52
	p value		0.46	0.75	**0.02**	0.07

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Younger females aged 15–24 years living in areas with seven or more outlets within a radius of 800 metres were 2.3 times more likely to consume hazardously than those living in neighbourhoods with no outlet (within 800 metres), after controlling for all potential confounding variables (Table 7.21).

7.6.1.3 Hazardous consumption by ethnic groups

After controlling for all potential confounding variables there was no association of European and Māori and Pacific Island people's hazardous consumption and density of alcohol outlets within an 800 metre buffer. Similar to other results described above there were significant results at baseline and after controlling for age and gender, but not thereafter (Appendix 28).

7.6.1.4 Hazardous consumption by ethnicity, gender and age group

Despite registering significant associations only at the baseline, analysis was performed for ethnicity stratified by gender and age group. Table 7.22 illustrates that after controlling for confounding variables, female Europeans had a positive association with increases in odds of consumption as the density of outlets increased. All results for other sub-groups including Māori and Pacific males and females, and European males were not significant. The results presented hereafter are mostly for European women. Significant results are presented from baseline because there are notable changes as adjustments were made. At baseline, female Europeans living in neighbourhoods with one to two outlets and seven or more outlets had 1.6 (CI 1.07–2.28) and 2.3 (CI 1.42–3.83) increased odds of hazardous consumption respectively, compared to the reference group. The tests of trends were also significant ($p < 0.05$) highlighting a positive association which indicated increasing odds of consumption as the density of outlets increased. When this analysis was adjusted for age, the ORs decreased marginally for those living in neighbourhoods with one to two and seven or more outlets. When the analysis was adjusted for urban/rural and deprivation, the odds ratio change was minimal for those living in neighbourhoods with seven or more outlets, but the results for those living in neighbourhoods with one to two outlets were no longer significant. After controlling for individual and area-level variables, European women living in neighbourhoods that had seven or more outlets within walking distance, had two times the odds of hazardous alcohol consumption compared to those living in neighbourhoods with no outlets within the 800 metre buffer.

More analysis was performed to see which age group contributes to the significant results evident in European female consumption. All the results, except for the age group 15–24, were insignificant (Appendix 29).

Table 7.22: Binary logistic regression of density of alcohol outlets within an 800 metres buffer on hazardous consumption of alcohol, by gender and ethnicity while adjusting for a range of individual characteristics and contextual variables.

		National																			
		Male European					**Male Māori and Pacific Island People**					**Female European**					**Female Māori and Pacific Island People**				
		Density of alcohol outlets within 800 metres buffer																			
		No outlet	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.05	1.05	1.06	1.02	1	1.17	1.05	1.56	1.11	1	**1.56**	1.43	**2.33**	1.28	1	0.81	0.97	1.20	1.05
	LCI		0.80	0.80	0.78	0.93		0.82	0.74	1.04	0.98		1.07	0.95	1.42	1.10		0.60	0.68	0.79	0.92
	UCI		1.38	1.37	1.45	1.12		1.67	1.50	2.34	1.25		2.28	2.14	3.83	1.49		1.11	1.37	1.82	1.19
	p value		0.71	0.75	0.71	0.67		0.38	0.77	0.03	0.10		**0.02**	0.09	**0.00**	**0.00**		0.20	0.84	0.40	0.49
Model 1 Age	**Odds Ratio**	1	1.01	0.97	0.92	0.98	1	1.06	0.89	1.41	1.08	1	**1.58**	1.38	**2.09**	**1.23**	1	0.77	0.88	1.17	1.03
	LCI		0.77	0.73	0.66	0.88		0.73	0.60	0.90	0.95		1.07	0.90	1.31	1.07		0.56	0.61	0.76	0.90
	UCI		1.33	1.28	1.29	1.08		1.54	1.32	2.21	1.23		2.36	2.12	3.34	1.42		1.07	1.27	1.79	1.18
	p value		0.93	0.83	0.62	0.62		0.76	0.57	0.13	0.24		**0.02**	0.14	**0.00**	**0.00**		0.12	0.50	0.47	0.69
Model 2 Urban/rural	**Odds Ratio**	1	1.03	0.99	0.94	0.98	1	1.06	0.89	1.41	1.06	1	1.53	1.33	**2.01**	1.21	1	0.74	0.85	1.12	1.02
	LCI		0.77	0.73	0.66	0.88		0.73	0.60	0.90	0.92		0.96	0.83	1.20	1.04		0.53	0.59	0.72	0.89
	UCI		1.37	1.33	1.33	1.09		1.54	1.32	2.21	1.21		2.44	2.13	3.35	1.42		1.04	1.24	1.73	1.17
	p value		0.84	0.94	0.73	0.73		0.76	0.57	0.13	0.42		0.07	0.24	**0.01**	**0.02**		0.09	0.40	0.62	0.81
Model 3 Area deprivation	**Odds Ratio**	1	1.04	0.97	0.90	0.97	1	1.00	0.84	1.31	1.03	1	1.56	1.37	2.05	1.22	1	0.72	0.77	0.99	0.98
	LCI		0.78	0.72	0.63	0.87		0.69	0.56	0.82	0.90		0.98	0.85	**1.22**	1.04		0.50	0.52	0.63	0.85
	UCI		1.39	1.30	1.30	1.08		1.44	1.25	2.07	1.19		2.48	2.19	3.45	1.42		1.02	1.13	1.55	1.12
	p value		0.79	0.82	0.58	0.56		0.98	0.39	0.25	0.65		0.06	0.20	**0.01**	**0.01**		0.06	0.18	0.97	0.73

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

Table 7.23: Binary logistic regression of density of alcohol outlets within an 800 metre buffer on hazardous consumption of alcohol for ethnicity, gender and age specific for the 15–24 age group, while adjusting for a range of individual characteristics and contextual variables

European Female 15–24						
Density of alcohol outlets within 800 metres buffer						
		No outlet	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.84	1.24	**4.83**	1.55
	LCI		0.80	0.51	1.94	1.16
	UCI		4.21	3.04	12.01	2.08
	p value		0.15	0.64	**0.00**	**0.00**
Model 1 Personal income	**Odds Ratio**	1	1.79	1.37	**4.96**	1.59
	LCI		0.75	0.55	1.94	1.17
	UCI		4.27	3.39	12.69	2.15
	p value		0.19	0.50	**0.00**	**0.00**
Model 2 Individual deprivation	**Odds Ratio**	1	1.79	1.35	**3.90**	1.47
	LCI		0.74	0.51	1.53	1.09
	UCI		4.31	3.62	9.93	1.98
	p value		0.20	0.55	**0.00**	**0.01**
Model 3 Urban/rural	**Odds Ratio**	1	1.59	1.17	**3.41**	1.41
	LCI		0.61	0.42	1.28	1.03
	UCI		4.11	3.26	9.09	1.93
	p value		0.34	0.77	**0.01**	**0.03**
Model 4 Area deprivation	**Odds Ratio**	1	1.62	1.18	**4.21**	1.46
	LCI		0.63	0.43	1.51	1.06
	UCI		4.20	3.20	11.74	2.01
	p value		0.32	0.75	**0.01**	**0.02**

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Younger European females (aged 15–24) had a statistically significant increase in the odds of hazardous consumption as the density of outlets increased. Table 7.23 indicates that after controlling for all potential confounding variables, including individual socio-economic status and area deprivation, younger European females had four times higher odds of hazardous consumption than if they lived in areas with seven or more outlets when compared to those of a similar age and gender who lived in areas with no outlet. The significant results that were evident earlier amongst younger females (Table 7.21) and Europeans (Table 7.22) can therefore be attributed to this age group (15–24).

7.6.1.5 Hazardous consumption in urban/rural areas

Analysis for hazardous consumption at both urban and rural levels showed contrasting results. While there was no ‘geography’ of hazardous consumption measured by walking distance to outlets in urban areas, the reverse was true in rural areas. As the number of outlets within the buffers *increased*, hazardous consumption *decreased*, indicating significant negative associations when a positive one was expected (Appendix 30). Moreover, an analysis by age indicated that adults (aged 55–64 years) residing in rural areas with one to two outlets within a walking distance had three times the odds of hazardous consumption compared to those of a similar age living in areas without an outlet (Appendix 31).

For both males and females in urban areas, after controlling for a range of confounding variables, there was no association between hazardous consumption and the density of outlets within buffers of 800 metres (Appendix 32). While there was a positive association of females' hazardous consumption and the density of outlets within walking distance in rural areas, after controlling for all confounding variables, this association was more strongly illustrated in neighbourhoods with one to two outlets. The results in Chapter 6 had shown that not many alcohol outlets were located within the 800 metre buffers in rural areas; therefore, not many neighbourhoods had seven or more outlets. Nonetheless, after controlling for all the confounding variables, including area deprivation, females living in rural areas had almost four and five times higher odds of hazardous consumption when living in areas that had one to two or two to six outlets within an 800 metre radius, when compared to those living in areas with no alcohol outlets within walking distance. Females in rural areas therefore have a 'geography' of hazardous consumption when living in areas with a relatively wider choice (one to six) of outlets within 800 metres walking distance.

7.6.2 Frequent consumption of five or more drinks

Similar analysis was repeated for frequent consumption. Results consistently showed that at national level, there was no association between frequent consumption and density even at baseline (Appendix 33).

7.6.2.1 Frequent consumption of five or more drinks by sub-populations of gender and age

At the national level, there was no association between male and female frequent consumption and the density of outlets within a walking distance (Appendix 34). Similarly for age, apart from males aged 25–34, where the relationship was in the opposite direction from that expected, there was no association between frequent consumption and density of outlets within walking distance, for all age groups when stratified by gender (Appendix 35).

7.6.2.2 Frequent consumption of five or more drinks by ethnic group

Table 7.24 indicates that after controlling for all variables, Māori and Pacific Island people living in neighbourhoods with seven or more outlets within walking distance had higher odds of frequent consumption. The results show that at baseline Māori and Pacific Island people living in close proximity to seven or more outlets have 1.6 times highest odds of frequent consumption compared to those who live in areas with no outlets. Despite slight increases in ORs (1.7 CI-1.1-2.12) when the analysis was adjusted for age and gender, the ORs attenuated with the addition of other control variables, including area deprivation, but they were still statistically significant. In short, after controlling for all confounding variables, Māori and Pacific Island people who live in areas with seven or more outlets had 1.5 higher odds of frequent consumption.

Table 7.24: Binary logistic regression of density of alcohol outlets within 800 metres buffer on frequent consumption of five drinks or more by ethnicity while adjusting for a range of individual characteristics and contextual variables

		European					Māori and Pacific Island People				
		Density of alcohol outlets within 800 metres buffer									
		No outlet	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**
Baseline Model	**Odds Ratio**	1	1.01	1.00	1.15	1.03	1	1.00	1.20	**1.64**	1.16
	LCI		0.84	0.82	0.90	0.96		0.78	0.94	1.24	1.06
	UCI		1.23	1.22	1.47	1.11		1.28	1.54	2.17	1.26
	p value		0.88	1.00	0.25	0.37		0.99	0.14	**0.00**	**0.00**
Model 1 Age and Gender	**Odds Ratio**	1	1.01	0.95	1.07	1.01	1	0.94	1.12	**1.70**	1.16
	LCI		0.82	0.77	0.83	0.94		0.72	0.86	1.27	1.06
	UCI		1.23	1.18	1.39	1.09		1.22	1.46	2.29	1.27
	p value		0.94	0.66	0.58	0.81		0.64	0.39	**0.00**	**0.00**
Model 2 Personal income	**Odds Ratio**	1	1.02	0.92	1.03	0.99	1	0.92	1.13	**1.61**	1.14
	LCI		0.83	0.74	0.79	0.92		0.71	0.86	1.18	1.04
	UCI		1.25	1.14	1.35	1.07		1.20	1.48	2.19	1.26
	p value		0.84	0.42	0.82	0.84		0.54	0.39	**0.00**	**0.01**
Model 3 Individual deprivation	**Odds Ratio**	1	1.02	0.91	1.00	0.98	1	0.91	1.10	**1.57**	1.13
	LCI		0.83	0.73	0.77	0.91		0.70	0.84	1.16	1.03
	UCI		1.25	1.13	1.31	1.06		1.19	1.45	2.14	1.24
	p value		0.89	0.37	0.98	0.69		0.50	0.48	**0.00**	**0.01**
Model 4 Urban/rural	**Odds Ratio**	1	1.07	0.96	1.07	1.01	1	0.92	1.11	**1.59**	1.14
	LCI		0.86	0.76	0.81	0.93		0.70	0.84	1.15	1.03
	UCI		1.34	1.22	1.41	1.09		1.21	1.47	2.19	1.26
	p value		0.55	0.75	0.64	0.88		0.55	0.46	**0.01**	**0.01**
Model 5 Area Deprivation	**Odds Ratio**	1	1.06	0.94	1.02	0.99	1	0.89	1.07	**1.53**	1.13
	LCI		0.85	0.75	0.77	0.91		0.68	0.80	1.10	1.02
	UCI		1.33	1.19	1.36	1.08		1.17	1.42	2.12	1.25
	p value		0.58	0.63	0.88	0.86		0.40	0.66	**0.01**	**0.02**

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Table 7.25: Binary logistic regression of density of alcohol outlets within 800 metres buffer on frequent consumption of five drinks or more by ethnicity and gender while adjusting for a range of individual characteristics and contextual variables

		European Male					**Male Māori and Pacific Island people**					**European Female**					**Female Māori and Pacific Island people**				
		Density of alcohol outlets within 800 metres buffer																			
	Distance	**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	0.93	0.98	1.07	1.01	1	1.06	1.12	**2.05**	1.19	1	1.21	1.08	1.42	1.10	1	0.89	1.30	1.44	1.14
	LCI		0.74	0.76	0.80	0.93		0.74	0.79	1.35	1.05		0.87	0.77	0.93	0.97		0.63	0.92	0.97	1.01
	UCI		1.18	1.26	1.43	1.11		1.52	1.60	3.10	1.35		1.67	1.53	2.17	1.24		1.24	1.83	2.14	1.29
	p value		0.56	0.85	0.66	0.77		0.74	0.53	**0.00**	**0.01**		0.26	0.65	0.10	0.15		0.48	0.14	0.07	0.03
Model 1	**Odds Ratio**	1	0.91	0.92	0.97	0.98	1	1.01	1.04	**2.04**	1.17	1	1.24	1.06	1.31	1.07	1	0.85	1.25	1.45	1.14
Age	**LCI**		0.72	0.71	0.72	0.90		0.70	0.72	1.32	1.03		0.88	0.74	0.86	0.94		0.61	0.87	0.96	1.00
	UCI		1.16	1.19	1.32	1.07		1.45	1.49	3.13	1.33		1.76	1.50	2.00	1.21		1.20	1.80	2.19	1.30
	p value		0.46	0.52	0.86	0.69		0.97	0.85	**0.00**	**0.01**		0.22	0.77	0.21	0.29		0.36	0.22	0.08	**0.04**
Model 2	**Odds Ratio**	1	0.97	0.98	1.04	1.01	1	1.00	1.02	**2.01**	1.17	1	1.25	1.06	1.32	1.07	1	0.88	1.29	1.50	1.16
Urban/rural	**LCI**		0.75	0.75	0.76	0.92		0.69	0.71	1.29	1.03		0.82	0.71	0.83	0.93		0.62	0.89	0.98	1.01
	UCI		1.24	1.29	1.43	1.11		1.44	1.48	3.12	1.34		1.89	1.58	2.09	1.23		1.25	1.87	2.31	1.33
	p value		0.81	0.88	0.79	0.86		0.98	0.90	**0.00**	**0.02**		0.30	0.79	0.24	0.36		0.48	0.18	0.06	**0.03**
Model 3	**Odds Ratio**	1	0.99	0.96	1.02	1.00	1	0.97	0.99	**1.94**	1.16	1	1.20	1.03	1.17	1.03	1	0.84	1.19	1.37	1.12
Area	**LCI**		0.77	0.73	0.74	0.91		0.67	0.68	1.25	1.02		0.80	0.69	0.73	0.90		0.58	0.81	0.88	0.98
Deprivation	**UCI**		1.28	1.27	1.42	1.10		1.39	1.44	3.03	1.33		1.81	1.53	1.86	1.18		1.20	1.74	2.13	1.29
	p value		0.93	0.79	0.90	1.00		0.85	0.97	**0.00**	**0.03**		0.38	0.89	0.52	0.67		0.34	0.37	0.17	0.10

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p<0.05)

More analysis was performed to identify which gender contributes most to this significant result. Table 7.25 indicates that significant results were found only for Māori and Pacific Island males where, after controlling for all potential confounding variables, there was a positive association between frequent consumption and density of outlets within walking distance. Even though the OR attenuated as control variables were added to the area deprivation model, significant results were consistent from the baseline, for those who live in neighbourhoods with seven or more outlets. Māori and Pacific Island males have increased odds of frequent consumption as the density of outlets increase.

Of all the age groups, only younger Māori and Pacific Island males aged 15–24 had statistically significant results warranting further analysis (Appendix 36). Table 7.26 shows that after controlling for all variables, there was no association of younger Māori and Pacific Island males who were frequent consumers with the density of outlets within buffers of 800 metres. Significant results were evident at baseline for younger male Māori and Pacific Island people living in areas with seven or more outlets who were three times more likely to consume frequently. Younger Māori and Pacific males' frequent consumption was most characteristic of both individual and area level socio-economic status.

Table 7.26: Binary logistic regression of density of alcohol outlets within 800 metres buffer on frequent consumption of five drinks or more by ethnicity, gender and specific age group-15–24

		Male Māori and Pacific Island people 15–24 years				
		Density of alcohol outlets within 800 metres buffer				
		No outlet	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	0.93	1.73	**2.83**	1.38
	LCI		0.43	0.78	1.14	1.04
	UCI		2.01	3.80	7.03	1.82
	p value		0.86	0.18	**0.03**	**0.03**
Model 1	**Odds Ratio**	1	0.86	1.70	2.35	1.33
Personal income	**LCI**		0.37	0.75	0.89	0.99
	UCI		1.99	3.82	6.20	1.78
	p value		0.73	0.20	0.09	0.06
Model 2	**Odds Ratio**	1	0.89	1.72	2.27	1.32
Individual deprivation	**LCI**		0.38	0.78	0.84	0.98
	UCI		2.08	3.79	6.15	1.78
	p value		0.80	0.18	0.11	0.07
Model 3	**Odds Ratio**	1	0.90	1.73	2.28	1.33
Urban/rural	**LCI**		0.38	0.76	0.83	0.98
	UCI		2.16	3.94	6.28	1.82
	p value		0.82	0.19	0.11	0.07
Model 4	**Odds Ratio**	1	0.98	1.98	2.36	1.40
Area deprivation	**LCI**		0.41	0.83	0.86	1.02
	UCI		2.38	4.72	6.47	1.92
	p value		0.97	0.12	0.10	**0.04**

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

7.6.2.3 Frequent consumption of five or more drinks in urban/rural areas

After controlling for potential confounding variables there was no association between frequent consumption and the density of alcohol outlets in both urban and rural areas

(Appendix 37). Significant results were observed when the data was adjusted for age and gender and ethnicity, but otherwise there was no association in either urban or rural areas.

There was no association between urban male and female frequent consumption and density of alcohol outlets within an 800 metres radius, but both males and females in rural areas had higher odds of frequent consumption if they were living in areas with three or more outlets (Appendix 38). Males and females living in rural areas with either three to six and seven or more outlets within walking distance, had almost six times higher odds of frequent consumption after controlling for all confounding variables.

More analysis of rural females revealed that at baseline, all age groups had significantly higher odds of hazardous consumption when living in areas with many alcohol outlets (Table 7.27) but because of relatively low numbers and no explanatory power when controlling for other variables, further analysis by age-group, is not reported.

Younger rural men aged 15–24, were the only males with noteworthy results and had nine times higher odds of consumption when living in areas with to one to six outlets. No further analysis was performed, while controlling for other confounders, for age groups in rural areas because of low numbers.

Table 7.27: Binary logistic regression of density of alcohol outlets within 800 metres buffer on frequent consumption of five drinks or more by location, gender (Females) and age group

		Density of alcohol outlets within 800 metres buffer				
Age group		**No outlet**	**1–2 outlets**	**3–6 outlets**	**7+ outlets**	**Test of trends**
15–24	**Odds Ratio**	1	4.40	2.07	**3.57**	1.72
	LCI		0.58	0.31	1.73	1.04
	UCI		33.58	13.54	7.36	2.83
	p value		0.15	0.45	**0.00**	**0.03**
25–34	**Odds Ratio**	1	1.27	**5.12**		2.07
	LCI		0.23	1.61		1.14
	UCI		6.83	16.29		3.78
	p value		0.78	**0.01**		**0.02**
35–44	**Odds Ratio**	1	1.40	**6.61**		1.83
	LCI		0.39	2.12		1.00
	UCI		4.98	20.64		3.34
	p value		0.60	**0.00**		**0.05**
45–54	**Odds Ratio**	1	3.56	**10.18**		2.25
	LCI		0.89	1.59		0.96
	UCI		14.20	65.16		5.30
	p value		0.07	**0.01**		**0.06**
55–64	**Odds Ratio**	1	**10.13**			1.60
	LCI		1.33			0.63
	UCI		77.10			4.07
	p value		**0.03**			0.32

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p <0.05)

7.6.3 Summary

This study found that there was no 'geography' nationally for all measures of alcohol-related behaviour and buffers of 800 metres. However, there were some sub-populations that, after controlling for a range of variables, had statistically significant increases in the odds of hazardous consumption as the number of outlets increased (Table 7.28). Younger European (15–24) females were more likely to consume hazardously when living in areas with many outlets within a walking distance. While the 'geography' for rural males was in the opposite direction, it was reversed for rural females. Māori and Pacific Island people residing in areas with a higher density of alcohol outlets had higher odds of frequent consumption, and males of the same ethnic groups who were frequent consumers, had a positive association with the higher density of outlets within an 800 metres buffer. Both rural males and females also had a significant positive association between frequent consumption and the density of alcohol outlets; however, analysis could not be undertaken for the different age groups because of low numbers. In summary, 'geography' measured by buffers of 800 metres, influenced different sub-populations depending on the alcohol-related behaviour measured. The next section examines the relationship of alcohol-related behaviour and the density of alcohol outlets, measured by number of alcohol outlets within driving distance (buffers of 3000 metres).

Table 7.28: Summary of results

		Alcohol-related behaviour	
Access	**Sub-groups**	**Hazardous consumption**	**Frequent consumption**
Density measures	Binary logistic regression	(n=9980) 0 = Non-Haz 1= Haz	(n=10,012) 0 = Non Freq 5 1 = Freq 5
Buffers of 800 metres			
0 = No outlet	**National**		
1 = 1–2 outlets	Whole population	Not significant	Not significant
2 = 3–6 outlets			
3 = >7 outlets	**Sub-Population**		
	Age and Gender	+ 15–24 Females	
	Ethnicity, age and gender	+ European Females	+ Māori and Pacific Island people
		+ 15–24 European Females	+ Male Māori and Pacific Island people
	Rural urban		
	Whole Population		
	Age and gender	– Rural dwellers	+ Rural males
		+ Rural females	+ Rural females

+ Relationship in expected direction

– Relationship in opposite direction-As density of outlets *increased* consumption *decreased*

Non-Haz = Non-hazardous consumption AUDIT score less than 8.

Haz = Hazardous consumption, AUDIT score of 8 or more.

Non- Freq 5 = consuming 5 drinks or more (on one occasion) less than once a month or never

Freq 5 = consuming 5 drinks or more (on one occasion) monthly, weekly or daily.

7.7 Buffers of 3000 metres

Similar analyses to those performed in the section above for an 800 metre buffer were also performed for the second measure of density, a buffer of 3000 metres. This measure is the exposure variable in predicting hazardous consumption and frequent consumption.

7.7.1 Hazardous consumption

7.7.1.1 Hazardous consumption nationally

At the national level, there was no association between hazardous consumption and density of alcohol outlets within a three kilometre driving distance after controlling for all confounding factors. However, at baseline, people living in neighbourhoods with 38 or more outlets within a radius of three kilometres had 1.5 (CI 1.15–1.84) increased odds of hazardous consumption compared to those living in neighbourhoods with no outlet (Appendix 39). The test of trends was also statistically significant. When this analysis was adjusted for age and gender, the OR for neighbourhoods with 38 or more outlets attenuated by 18% and was not statistically significant showing that hazardous consumption was mediated by age and gender. When ethnicity and personal income was added, the ORs increased and were statistically significant showing that people living in neighbourhoods with 38 or more outlets within a radius of three kilometres had 1.3 times (CI 1.00–1.68) increased odds of hazardous consumption. The addition of the final control variables of individual deprivation, urban/rural location and area deprivation attenuated the OR, and the relationship between hazardous consumption and those living in neighbourhoods with 38 or more outlets within a radius of three kilometres disappeared. This shows that this association was mediated by age and gender, individual deprivation, urban/rural location and area deprivation.

7.7.1.2 Hazardous consumption by sub-population: Gender and Age

Analysis by gender at a national level showed that after controlling for all confounding variables, while the test of trends was significant, there was no significant relationship between hazardous consumption among women and the density of alcohol outlets. Similarly, there was no ‘geography’ of hazardous consumption for males (Appendix 40).

Analysis for gender by age group showed significant results in middle aged males (55–64) (Appendix 41). Middle aged males had 8.5, 8.4 and 8.9 times increased odds of consuming alcohol hazardously when they lived in neighbourhoods with 1–13, 14–37 and 38 or more outlets respectively, within a driving distance of three kilometres after controlling for all potential confounding variables (Table 7.29). It was interesting to note that all three divisions were consistently significant and the ORs doubled from baseline to the point when the last control variable, area deprivation, was added. However, since there was no clear gradient, the tests of trends were not significant.

Table 7.29: Binary logistic regression of density of alcohol outlets within a 3000 metre buffer on hazardous consumption by gender and a specific age group (males 55–64) while adjusting for a range of individual characteristics and contextual variables

		Density of alcohol outlets within 3000 metres buffer				
		No outlet	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**
Baseline Model	**Odds Ratio**	1	**4.75**	**3.78**	**3.69**	1.13
	LCI		1.77	1.39	1.34	0.93
	UCI		12.72	10.29	10.16	1.39
	p value		**0.00**	**0.01**	**0.01**	0.22
Model 1 Ethnicity	**Odds Ratio**	1	**4.85**	**3.97**	**3.93**	1.16
	LCI		1.80	1.46	1.42	0.94
	UCI		13.03	10.82	10.88	1.42
	p value		**0.00**	**0.01**	**0.01**	0.16
Model 2 Personal income	**Odds Ratio**	1	**4.61**	**3.29**	**3.51**	1.11
	LCI		1.69	1.20	1.25	0.89
	UCI		12.57	8.99	9.81	1.37
	p value		**0.00**	**0.02**	**0.02**	0.35
Model 3 Individual deprivation	**Odds Ratio**	1	**4.27**	**3.02**	**3.25**	1.09
	LCI		1.57	1.12	1.16	0.87
	UCI		11.65	8.16	9.07	1.35
	p value		**0.01**	**0.03**	**0.03**	0.45
Model 4 urban/rural	**Odds Ratio**		**7.30**	**6.45**	**6.89**	1.20
	LCI		2.17	1.75	1.81	0.91
	UCI		24.50	23.79	26.16	1.58
	p value		**0.00**	**0.01**	**0.01**	0.19
Model 5 Area Deprivation	**Odds Ratio**	1	**8.54**	**8.40**	**8.85**	1.27
	LCI		2.53	2.20	2.29	0.96
	UCI		28.88	32.08	34.30	1.67
	p value		**0.00**	**0.00**	**0.00**	0.09

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

7.7.1.3 Hazardous consumption by ethnic group

Table 7.30 illustrates that there was no association of male and female Europeans and Māori and Pacific Island people with hazardous consumption and the density of alcohol outlets within 3000 metres. At baseline and after controlling for age, statistically significant results in the expected direction were observed for female Europeans and Māori and Pacific Island males. When other control variables were added, however, the ORs attenuated and were no longer significant.

As with other previous analysis, the association between ethnic groups' hazardous consumption and driving distance (3000 metre buffer) was modified by both individual and contextual factors and therefore there was no 'geography' of ethnic hazardous consumption.

7.7.1.4 Hazardous consumption by ethnicity, gender and age group

Analysis stratified by age groups revealed statistically significant patterns in different age groups for Europeans and Māori and Pacific Island people (Appendix 42). Significant results were recorded in middle aged European males (55–64 years) and younger Māori and Pacific Island females aged 25–34. The next step was to analyse both these age groups while controlling for a range of confounding variables.

There was a strong and statistically significant association of middle aged European men (55–64 years) who were hazardous consumers and the density of alcohol outlets within driving distance. Table 7.31 illustrates that after controlling for all confounding variables, middle aged European men living in neighbourhoods that had 1–13, 14–37 and 38 or more outlets have 9.6, 10.2 and 11.2 higher odds of hazardous consumption respectively, compared to people of similar ages living in areas with no outlets within a radius of three kilometres. These results were similar to earlier analysis above that indicated that middle aged males' hazardous consumption had a positive association with density of outlets. These results for European males related to men of a similar age (55-64) (Table 7.29). While at baseline the ORs were 4.9, 4.1 and 4.4 within 1–13, 14–37 and 38 or more outlets respectively, they attenuated when the analysis was adjusted for personal income and individual deprivation.

Table 7.30: Binary logistic regression of density of alcohol outlets within a 3000 metre buffer on hazardous consumption of alcohol stratified by ethnicity and gender, while adjusting for a range of individual characteristics and contextual variables.

		European Male					Male Māori and Pacific Island people					European Female					Female Māori and Pacific Island people				
		Density of alcohol outlets within 3000 metres buffer																			
	Distance	**No outlet**	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	0.99	0.97	1.37	1.13	1	**1.81**	**1.93**	**1.88**	1.12	1	1.19	1.31	**2.42**	1.39	1	1.17	1.14	1.11	1.01
	LCI		0.69	0.68	0.97	1.02		1.12	1.20	1.16	0.98		0.64	0.72	1.33	1.16		0.66	0.65	0.62	0.87
	UCI		1.41	1.38	1.95	1.26		2.91	3.11	3.05	1.28		2.21	2.37	4.41	1.66		2.09	2.02	1.99	1.16
	p value		0.94	0.86	0.08	**0.03**		**0.02**	**0.01**	**0.01**	0.11		0.57	0.38	**0.00**	**0.00**		0.59	0.65	0.73	0.94
Model 1 Age	**Odds Ratio**	1	1.04	1.01	1.16	1.05	1	**1.65**	1.61	1.54	1.05	1	1.24	1.31	**2.15**	1.30	1	1.13	1.07	0.92	0.94
	LCI		0.72	0.71	0.81	0.94		1.00	0.98	0.93	0.91		0.67	0.73	1.20	1.10		0.62	0.59	0.50	0.81
	UCI		1.51	1.44	1.65	1.16		2.71	2.65	2.56	1.22		2.30	2.36	3.85	1.54		2.07	1.94	1.70	1.10
	p value		0.81	0.95	0.41	0.40		**0.05**	0.06	0.09	0.50		0.49	0.37	**0.01**	**0.00**		0.68	0.84	0.80	0.44
Model 2 Urban/rural	**Odds Ratio**	1	1.28	1.30	1.49	1.10	1	1.53	1.47	1.41	0.99	1	1.20	1.25	2.06	1.33	1	0.96	0.86	0.75	0.89
	LCI		0.79	0.77	0.88	0.96		0.80	0.70	0.67	0.83		0.47	0.48	0.77	1.08		0.48	0.41	0.35	0.75
	UCI		2.05	2.20	2.54	1.26		2.94	3.06	2.96	1.19		3.05	3.29	5.46	1.64		1.92	1.80	1.58	1.06
	p value		0.32	0.33	0.14	0.16		0.20	0.31	0.37	0.93		0.70	0.65	0.15	**0.01**		0.91	0.69	0.45	0.19
Model 3 Area Deprivation	**Odds Ratio**	1	1.22	1.24	1.42	1.10	1	1.37	1.30	1.22	0.97	1	1.25	1.31	2.13	1.33	1	0.81	0.72	0.59	0.85
	LCI		0.75	0.72	0.82	0.95		0.71	0.63	0.58	0.74		0.50	0.51	0.82	1.08		0.44	0.37	0.30	0.72
	UCI		1.99	2.13	2.47	1.26		2.62	2.69	2.57	0.81		3.13	3.38	5.51	1.63		1.50	1.38	1.16	1.01
	p value		0.43	0.45	0.21	0.19		0.35	0.48	0.60	1.16		0.63	0.58	0.12	**0.01**		0.51	0.32	0.13	0.06

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p <0.05)

When the analysis was adjusted for urban/rural location, the ORs almost doubled and further increased when the final control, area deprivation was added.

Table 7.31: Binary logistic regression of the density of alcohol outlets within a 3000 metre buffer on hazardous consumption by ethnicity, gender and a specific age group (55–64) while adjusting for a range of individual characteristics and contextual variables.

European Males 55–64						
Density of alcohol outlets within 3000 metres buffer						
		No outlet	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	**4.93**	**4.08**	**4.15**	1.18
	LCI		1.57	1.28	1.27	0.93
	UCI		15.53	13.00	13.54	1.48
	p value		**0.01**	**0.02**	**0.02**	0.17
Model 1	**Odds Ratio**	1	**4.44**	**3.34**	**3.58**	1.12
Personal income	**LCI**		1.41	1.06	1.10	0.88
	UCI		13.96	10.54	11.61	1.43
	p value		**0.01**	**0.04**	**0.03**	0.34
Model 2	**Odds Ratio**	1	**4.29**	**3.17**	**3.50**	1.12
Individual deprivation	**LCI**		1.37	1.02	1.09	0.88
	UCI		13.47	9.85	11.28	1.42
	p value		**0.01**	**0.05**	**0.04**	0.37
Model 3	**Odds Ratio**	1	**7.92**	**7.68**	**8.48**	1.28
Urban/rural	**LCI**		2.08	1.82	1.94	0.94
	UCI		30.08	32.53	37.03	1.75
	p value		**0.00**	**0.01**	**0.01**	0.12
Model 4	**Odds Ratio**	1	**9.63**	**10.27**	**11.25**	1.35
Area deprivation	**LCI**		2.54	2.36	2.55	0.99
	UCI		36.46	44.76	49.67	1.85
	p value		**0.00**	**0.00**	**0.00**	0.06

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

There was no association of younger Māori and Pacific Island females (aged 25–34) hazardous consumption and buffers of 3000 metres, after controlling for all potential confounding variables, as this association was mediated by urban/rural location and area deprivation (Table 7.32). Hazardous consumption has no association with driving distance for younger Māori and Pacific Island females.

Table 7.32: Binary logistic regression of density of alcohol outlets within a 3000 metre buffer on hazardous consumption by ethnicity, gender and a specific age group (25–34) while adjusting for a range of individual characteristics and contextual variables.

		25–34 year old female Māori and Pacific Island people				
		Density of alcohol outlets within a 3000 metre buffer				
		No outlet	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	**2.64**	1.90	1.53	0.94
	LCI		1.00	0.71	0.56	0.73
	UCI		6.93	5.08	4.18	1.21
	p value		**0.05**	0.20	0.40	0.62
Model 1 Personal income	**Odds Ratio**	1	**2.83**	1.91	1.85	0.99
	LCI		1.11	0.73	0.69	0.76
	UCI		7.19	5.01	4.94	1.29
	p value		**0.03**	0.19	0.22	0.94
Model 2 Individual deprivation	**Odds Ratio**	1	**3.04**	2.06	1.94	0.99
	LCI		1.20	0.79	0.72	0.77
	UCI		7.65	5.39	5.21	1.29
	p value		**0.02**	0.14	0.19	0.97
Model 3 Urban/rural	**Odds Ratio**	1	2.09	1.31	1.23	0.85
	LCI		0.67	0.38	0.35	0.63
	UCI		6.52	4.57	4.38	1.16
	p value		0.21	0.67	0.75	0.31
Model 4 Area deprivation	**Odds Ratio**	1	1.78	1.06	0.96	0.80
	LCI		0.57	0.31	0.27	0.59
	UCI		5.53	3.60	3.41	1.09
	p value		0.32	0.93	0.95	0.16

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (P= <0.05)

7.7.1.5 Hazardous consumption in urban/rural areas

Similar to the national results, there was no 'geography' for hazardous consumption for either urban or rural areas (Appendix 43). The next step therefore was to examine the gender relationship. Rural males' frequent consumption had a positive association with the density of outlets within a 3000 metre buffer. Males living in rural areas with 38 or more outlets had 2.2 higher odds of hazardous consumption when compared to those who live in neighbourhoods with no outlet within a driving distance of three kilometres. The ORs for rural areas increased as control variables were added. Females in both urban and rural areas presented no significant results; however, while the rural females had no significant results, urban females presented interesting results as control variables were introduced, even though after controlling for all variables there was no 'geography'. At baseline, rural females living in neighbourhoods with 38 or more outlets within a radius of three kilometres had 1.9 (CI 1.19–2.91) times increased odds of hazardous consumption (Appendix 44). The ORs attenuated after controlling for age, but were still significant. This pattern changed with increases in ORs when ethnicity and personal income were added as control variables, but again attenuated with the addition of individual deprivation. When area deprivation was added, the ORs attenuated further and were no longer significant, showing that this relationship was mostly influenced by location and area deprivation. Most rural areas did not have many people residing in areas with 38 or more outlets within 3000 metres buffers hence no data for 38 or more outlets column (Appendix 44).

7.7.2 Frequent consumption of five or more drinks

7.7.2.1 Frequent consumption of five or more drinks nationally

There was no national ‘geography’ of frequent consumption (Appendix 45)

7.7.2.2 Frequent consumption of five or more drinks by sub-population: Gender and Age

Examination of frequent consumption by gender reveals that after controlling for all potential confounding variables, there was no national ‘geography’ (Appendix 46). In brief, females have significant results at baseline and again after controlling for age and ethnicity. When this gender analysis was undertaken for all age group, no age group had significant results at baseline (Appendix 47).

7.7.2.3 Frequent consumption of five or more drinks by ethnic group

European and Māori and Pacific Island people had no ‘geography’ of frequent consumption after controlling for confounding variables (Appendix 48). Further analysis was, therefore, undertaken by gender and age group

7.7.2.4 Frequent consumption of five or more drinks by ethnicity, gender and age group

After controlling for potential confounding variables it was found that there was no ‘geography’ of frequent consumption for ethnicity stratified by gender (Table 7.33). While there was a result showing significance for European females at baseline and after controlling for age, when the final control variables were added, these relationships dissipated showing that frequent consumption was most influenced by location and area deprivation.

Some age groups exhibited significant results and were examined further. These were younger Māori and Pacific Island females (aged 25–34); European women aged 35–44, middle aged European males, and Māori and Pacific Island females, both aged 55–64 (Appendix 49).

Young Māori and Pacific Island females aged 25–34 who were frequent consumers had a positive association with the density of alcohol outlets within a 3000 metre buffer, after controlling for all potential confounding variables. All results from the baseline were highlighted because of the interesting results in each step. At baseline young Māori and Pacific Island females living in neighbourhoods with 1–13 outlets within a radius of three kilometres had 3.3 (CI 1.31–8.30) times higher odds of frequent consumption. The OR increased marginally to 3.4 (CI 1.31–8.68) when the analysis was adjusted for personal income, and further increased when individual deprivation was added. Neighbourhoods with 14–37 outlets, which hitherto were not significant, now became so. When the final control variable, individual deprivation, was added the ORs for those living in neighbourhoods with 1–13 and 14–37 outlets and who were frequent consumers increased to 5.4 (CI 1.67–17.7) and 3.8 (1.03–13.94) times higher than the those living in neighbourhoods with no outlets respectively (see Table 7.34).

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Table 7.33: Binary logistic regression of density of alcohol outlets within a 3000 metre buffer on frequent consumption of alcohol, stratified by ethnicity and gender, while adjusting for a range of individual characteristics and contextual variables.

		European Male					Male Māori and Pacific Island people					European Female					Female Māori and Pacific Island people				
		Density of alcohol outlets within 3000 metres buffer																			
	Distance	No outlet	1–13 outlets	14–37 outlets	38+ outlets	Test of trends	No outlet	1–13 outlets	14–37 outlets	38+ outlets	Test of trends	No outlet	1–13 outlets	14–37 outlets	38+ outlets	Test of trends	No outlet	1–13 outlets	14–37 outlets	38+ outlets	Test of trends
Baseline	**Odds Ratio**	1	0.87	0.81	1.12	1.06	1	1.33	1.51	1.58	1.13	1	1.53	1.42	**1.73**	1.13	1	1.17	1.05	1.13	1.01
	LCI		0.63	0.58	0.81	0.96		0.82	0.95	0.97	0.98		0.94	0.88	1.06	0.98		0.67	0.61	0.65	0.87
	UCI		1.19	1.11	1.54	1.17		2.14	2.41	2.55	1.30		2.48	2.28	2.82	1.29		2.03	1.81	1.97	1.16
	p value		0.39	0.19	0.50	0.22		0.25	0.08	0.06	0.09		0.09	0.15	**0.03**	0.08		0.59	0.86	0.67	0.92
Model 1 Age	**Odds Ratio**	1	0.92	0.85	0.97	0.99	1	1.23	1.29	1.33	1.07	1	**1.68**	1.50	1.56	1.07	1	1.15	1.00	0.99	0.96
	LCI		0.68	0.62	0.71	0.91		0.74	0.79	0.80	0.92		1.00	0.91	0.94	0.93		0.65	0.57	0.55	0.83
	UCI		1.27	1.17	1.33	1.09		2.05	2.13	2.24	1.24		2.81	2.47	2.60	1.22		2.05	1.76	1.77	1.11
	p value		0.63	0.31	0.84	0.91		0.43	0.31	0.28	0.36		**0.05**	0.11	0.08	0.34		0.63	1.00	0.98	0.59
Model 2 Urban/rural	**Odds Ratio**	1	1.19	1.16	1.33	1.07	1	1.25	1.31	1.35	1.06	1	1.96	1.85	1.94	1.07	1	1.21	1.07	1.05	0.96
	LCI		0.78	0.73	0.84	0.96		0.64	0.64	0.65	0.88		0.95	0.86	0.88	0.91		0.59	0.49	0.48	0.80
	UCI		1.81	1.85	2.11	1.21		2.42	2.71	2.83	1.26		4.07	4.02	4.27	1.27		2.46	2.32	2.32	1.15
	p value		0.41	0.52	0.22	0.23		0.52	0.46	0.42	0.55		0.07	0.12	0.10	0.41		0.60	0.87	0.90	0.67
Model 3 Area Deprivation	**Odds Ratio**	1	1.14	1.11	1.27	1.07	1	1.18	1.24	1.27	1.05	1	1.81	1.71	1.72	1.04	1	1.10	0.95	0.91	0.93
	LCI		0.74	0.69	0.79	0.95		0.60	0.60	0.60	0.88		0.89	0.80	0.79	0.88		0.57	0.46	0.43	0.78
	UCI		1.76	1.78	2.05	1.20		2.32	2.58	2.67	1.25		3.71	3.67	3.73	1.23		2.14	1.96	1.91	1.11
	p value		0.55	0.68	0.33	0.29		0.63	0.56	0.53	0.62		0.10	0.17	0.17	0.62		0.78	0.90	0.80	0.42

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p <0.05)

Table 7.34: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of alcohol stratified by ethnicity, gender and specific age group 25–34 while adjusting for a range of individual characteristics and contextual variables

Female Māori and Pacific Island people aged 25–34						
Density of alcohol outlets within 3000 metres buffer						
		No outlet	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	**3.30**	2.12	1.98	0.98
	LCI		1.31	0.86	0.8	0.76
	UCI		8.30	5.21	4.87	1.25
	p value		**0.01**	0.10	0.14	0.86
Model 1	**Odds Ratio**	1	**3.38**	2.21	2.22	1.02
Personal income	**LCI**		1.31	0.89	0.89	0.79
	UCI		8.68	5.44	5.53	1.32
	p value		**0.01**	0.09	0.09	0.87
Model 2	**Odds Ratio**	1	**3.67**	**2.40**	2.32	1.02
Individual deprivation	**LCI**		1.47	1.00	0.95	0.79
	UCI		9.16	5.77	5.65	1.31
	p value		**0.01**	**0.05**	0.06	0.87
Model 3	**Odds Ratio**	1	**5.21**	**3.65**	3.52	0.98
Urban/rural	**LCI**		1.63	1.02	0.97	0.72
	UCI		16.65	13.05	12.77	1.34
	p value		**0.01**	**0.05**	0.06	0.92
Model 4	**Odds Ratio**	1	**5.44**	**3.79**	3.69	0.98
Area deprivation	**LCI**		1.67	1.03	0.97	0.72
	UCI		17.70	13.94	13.99	1.34
	p value		**0.01**	**0.05**	0.06	0.89

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Table 7.35 indicates that for European women aged 35–44 there was no ‘geography’ of frequent consumption.

Table 7.35: Binary logistic regression of density of alcohol outlets within a 3000 metre buffer on frequent consumption of alcohol stratified by ethnicity, gender and specific age group 35–44 while adjusting for a range of individual characteristics and contextual variables

European Females 35–44						
Density of alcohol outlets within 3000 metres buffer						
		No outlet	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	**2.54**	1.41	1.66	0.98
	LCI		1.05	0.55	0.65	0.77
	UCI		6.15	3.57	4.25	1.24
	p value		**0.04**	0.47	0.29	0.85
Model 1 Personal income	**Odds Ratio**	1	**2.57**	1.39	1.62	0.97
	LCI		1.05	0.55	0.62	0.75
	UCI		6.31	3.50	4.27	1.24
	p value		**0.04**	0.49	0.33	0.80
Model 2 Individual deprivation	**Odds Ratio**	1	2.39	1.25	1.53	0.96
	LCI		0.97	0.48	0.57	0.74
	UCI		5.88	3.28	4.12	1.24
	p value		0.06	0.65	0.40	0.74
Model 3 Urban/rural	**Odds Ratio**	1	1.71	0.81	0.98	0.82
	LCI		0.55	0.22	0.26	0.58
	UCI		5.31	3.02	3.66	1.17
	p value		0.36	0.75	0.98	0.27
Model 4 Area deprivation	**Odds Ratio**	1	1.55	0.69	0.83	0.78
	LCI		0.48	0.18	0.21	0.55
	UCI		4.96	2.67	3.24	1.12
	p value		0.46	0.59	0.79	0.18

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

After a range of potentially confounding variables was controlled for, middle aged European males (55–64) were found to have statistically significant higher odds of frequent consumption as the density of alcohol outlets increased within a radius of three kilometres (Table 7.36). The odds varied from 4.15, 4.43 to 6.40 when residing in areas with 1–13, 14–37 and 38 or more outlets respectively. The test of trend was also significant. The association between middle aged Māori and Pacific Island females' frequent consumption and distance, however, was in the opposite, negative direction. Frequent consumption decreased with an increase in the density of alcohol outlets after controlling for all potential confounding variables with those living in areas with 1–13 outlets being 93% less likely to consume frequently.

Table 7.36*:* Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of alcohol stratified by ethnicity, gender and specific age group 55–64 while adjusting for a range of individual characteristics and contextual variables.

		55–64 Male European					55–64 Female Māori and Pacific Island people				
		Density of alcohol outlets within 3000 metres buffer									
		No outlet	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	**2.18**	1.83	**2.27**	1.15	1	**0.16**	**0.08**	0.43	0.80
	LCI		1.01	0.86	1.03	0.93		0.03	0.01	0.08	0.35
	UCI		4.70	3.91	5.04	1.43		0.87	0.44	2.29	1.82
	p value		**0.05**	0.12	**0.04**	0.20		**0.03**	**0.00**	0.33	0.59
Model 1	**Odds Ratio**	1	1.89	1.43	2.01	1.11	1	**0.14**	**0.10**	0.80	1.07
Personal income	**LCI**		0.86	0.66	0.89	0.88		0.02	0.02	0.13	0.40
	UCI		4.16	3.11	4.54	1.40		0.97	0.68	5.07	2.89
	p value		0.11	0.36	0.09	0.36		**0.05**	**0.02**	0.81	0.89
Model 2	**Odds Ratio**	1	1.95	1.46	2.08	1.12	1	**0.09**	**0.08**	1.00	1.21
Individual deprivation	**LCI**		0.89	0.68	0.93	0.89		0.01	0.01	0.14	0.41
	UCI		4.25	3.16	4.67	1.40		0.59	0.50	6.92	3.54
	p value		0.09	0.33	0.07	0.34		**0.01**	**0.01**	1.00	0.73
Model 3	**Odds Ratio**	1	**4.18**	**4.40**	**6.25**	1.42	1	0.15	0.23	2.95	2.26
Urban/rural	**LCI**		1.42	1.30	1.81	1.05		0.02	0.02	0.25	0.71
	UCI		12.27	14.84	21.58	1.91		1.12	2.17	34.74	7.19
	p value		**0.01**	**0.02**	**0.00**	**0.02**		0.06	0.20	0.39	0.17
Model 4	**Odds Ratio**	1	**4.15**	**4.43**	**6.40**	1.43	1	**0.07**	0.12	1.02	1.86
Area deprivation	**LCI**		1.41	1.30	1.85	1.06		0.01	0.01	0.06	0.69
	UCI		12.20	15.13	22.13	1.93		0.58	1.38	16.58	5.04
	p value		**0.01**	**0.02**	**0.00**	**0.02**		**0.01**	0.09	0.99	0.22

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

7.7.2.5 Frequent consumption of five or more drinks in urban/rural areas

Results for both urban and rural areas indicate contrasting results. While there was no 'geography' of frequent consumption in the former, the reverse was observed in the latter. After all variables were controlled for, the odds were three times higher for people living in rural areas with 14–37 outlets to be consuming alcohol frequently (Appendix 50). These results also show that very few rural areas had neighbourhoods with 38 or more outlets within three kilometres, as was observed in Chapter 6.

Examination of frequent consumption by gender reveals statistically significant results only amongst rural males and females (Appendix 51). Rural males and females living in neighbourhoods with 14–37 and 1–13 outlets within three kilometres radius had 2.5 and 1.8 higher odds of frequent consumption of five or more drinks respectively; after all confounding variables were controlled for.

Analysis by different age groups for rural males and females identified both rural females and males aged 35–44, rural females aged 45–54 and rural males aged 55–64 as having significant results for further analysis (Table 7.37). However, because of low numbers, further analysis while controlling for other confounding variables was not undertaken.

Table 7.37*: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of alcohol stratified by location, gender and age group*

		Rural females					Rural males				
		Density of alcohol outlets within 3000 metres buffer									
Age group		**No outlet**	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1–13 outlets**	**14–37 outlets**	**38+ outlets**	**Test of trends**
15–24	**Odds Ratio**	1	2.96	0.59		1.74	1	0.94			0.94
	LCI		0.81	0.03		0.57		0.26			0.26
	UCI		10.77	10.85		5.31		3.45			3.45
	p value		0.10	0.73		0.33		0.93			0.93
25–34	**Odds Ratio**	1	1.54			2.37	1	0.27			0.26
	LCI		0.50			0.90		0.07			0.07
	UCI		4.74			6.27		1.06			0.96
	p value		0.45			0.08		0.06			**0.04**
35–44	**Odds Ratio**	1	2.09	**5.66**		2.20	1	0.75	**4.98**		1.13
	LCI		0.78	1.17		1.00		0.33	1.25		0.50
	UCI		5.62	27.34		4.86		1.72	19.88		2.55
	p value		0.14	**0.03**		**0.05**		0.50	**0.02**		0.77
45–54	**Odds Ratio**	1	1.75	**4.36**		1.85	1	1.37			1.53
	LCI		0.70	2.38		0.92		0.57			0.68
	UCI		4.39	7.99		3.73		3.27			3.46
	p value		0.23	**0.00**		0.08		0.48			0.31
55–64	**Odds Ratio**	1	1.73			1.28	1	**4.86**			4.23
	LCI		0.27			0.31		1.91			1.67
	UCI		10.90			5.25		12.37			10.69
	p value		0.56			0.73		**0.00**			**0.00**
65–74	**Odds Ratio**	1					1	0.84			0.74
	LCI							0.26			0.26
	UCI							2.74			2.11
	p value							0.78			0.57

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

7.7.3 Summary

For all related measures of alcohol-related behaviour, hazardous and frequent consumption of five or more drinks, there was no national ‘geography’ measured by the density of alcohol outlets within driving distance to alcohol outlets. However, there were some significant results for different sub-populations (Table 7.38). Once potential confounding variables had been controlled for, middle aged European males (55–64 years) had increasing odds of hazardous consumption associated with increases in the density of alcohol outlets within a radius of three kilometres from where they lived. This shows that they had a wide choice of outlets from which to get alcohol. Significantly, for frequent consumers, after controlling for all potential confounding variables, it was found that younger Māori and Pacific Island females aged 35–34, middle aged European females (55-64) and Māori and Pacific Island people (55–64), as well as rural males and females, had increased odds of frequent consumption when living in areas with many outlets compared to those without. The results for buffers of 3000 metres, therefore, showed significant increases in odds for different sub-populations.

Table 7.38: Summary of results

		Alcohol-related behaviour	
Access	**Sub-groups**	**Hazardous consumption**	**Frequent consumption**
Density measures	**Binary logistic regression**	(n=9980) 0 = Non-Haz 1= Haz	(n=10,012) 0 = Non Freq 5 1 = Freq 5
Buffers of 3000 metres			
0 = No outlet	**National**		
1 = 1–13 outlets	Whole population	Not significant	Not significant
2 = 14–37 outlets			
3 = >38 outlets	**Sub-Population**		
	Age and Gender	+ 55–64 males	
	Ethnicity, age and gender	+ 55–64 European males	+ 25–34 Female Māori and Pacific Island people + 55–64 European males + 55–64 Female Māori and Pacific Island people
	Rural urban		
	Whole Population		
	Age and gender	– Rural males	+ Rural females + Rural males

+ Relationship in expected direction Relationship in opposite direction-As density of outlets *increased* consumption *decreased*

Non-Haz = Non-hazardous consumption, AUDIT score less than 8.

Haz = Hazardous consumption, AUDIT score of 8 or more.

Non- Freq 5 = consuming 5 drinks or more (on one occasion) less than once a month or never

Freq 5 = consuming 5 drinks or more (on one occasion) monthly, weekly or daily.

7.8 Chapter Summary

The main aim of this chapter was to understand whether proximity to alcohol outlets had an independent association with alcohol consumption. Alcohol consumption was measured in two ways; hazardous consumption and frequent consumption (of five or more drinks on one occasion whether, monthly, weekly, or daily). This was also true of proximity to alcohol outlets, which was considered in terms of both access distance and density (Table 7.1). Table 7.39 summarises the results and indicates that for alcohol-related behaviour, there was no association between both hazardous or frequent consumption, and proximity to alcohol outlets at the national level for the general population. However, when analysis was undertaken for different sub-populations, there were significant associations.

Table 7.39: Summary of all results combined

		Alcohol-related behaviour	
Access	Sub-groups	Hazardous consumption	Frequent consumption
Distance measures	Population	(n=9980) 0 = Non-Haz 1= Haz	(n=10,012) 0 = Non Freq 5 1 = Freq 5
Nearest distance to alcohol outlet 1 = 0–571m 2 = 572m–995m 3 = 996–2160m 4 = >2161m	National Population as a whole Sub-Population Age and gender Ethnicity, age and gender Rural urban Whole population Age and gender	 Not significant + 75+ Males +15–24 Male Māori and Pacific Island people + Rural women ─ Rural men	 Not significant + Middle aged 45–54 men + Europeans + Male Māori and Pacific Island People + Rural women ─ Rural men
+ Relationship in expected direction, negative association as distance increase consumption reduces ─ Relationship in opposite direction-Consumption increased as distance *increased*			
Density measures Buffers of 800 metres 0 = No outlet 1 = 1–2 outlets 2 = 3–6 outlets 3 = >7 outlets	National Whole population Sub-Population Age and gender Ethnicity, age and gender Rural urban Whole population Age and gender	 Not significant + 15–24 females + European females +15–24 European females ─ Rural dwellers + Rural females	 Not significant + Māori and Pacific Island people + Male Māori and Pacific Island people + Rural males + Rural females
Buffers of 3000 metres 0 = No outlet 1 = 1–13 outlets 2 = 14–37 outlets 3 = >38 outlets	National Whole population Sub-Population Age and gender Ethnicity, age and gender Rural urban Whole population Age and gender	 Not significant + 55–64 males +55–64 European males ─ Rural males	 Not significant +25–34 Female Māori and Pacific Island people + 55–64 European males ─55–64 Female Māori and Pacific Island people + Rural females + Rural males

+ Relationship in expected direction

─ Relationship in opposite direction- Consumption *decreased* as density of outlets *increased*

Non-Haz = Non-hazardous consumption, AUDIT score less than 8.

Haz = Hazardous consumption - AUDIT score of 8 or more.

Non- Freq 5 = consuming 5 drinks or more (consumed on one occasion) less than once a month or never

Freq 5 = consuming 5 drinks or more (consumed on one occasion) monthly, weekly or daily.

The analysis was further stratified by different sub-populations and significant results were noted amongst Māori and Pacific Island people. For these ethnic minority groups, younger males aged 15–24 were more likely to have higher odds of hazardous consumption when living less than 571 metres from an alcohol outlet even after controlling for a range of potential confounding variables. As distance from outlets increased, hazardous consumption reduced, a trend not witnessed in Europeans of similar ages. Elderly Europeans aged 75 and over were also more likely to consume hazardously when living closer to alcohol outlets.

Significant results were also observed when the 'place' features were measured by the density of alcohol outlets (using 800 metre and 3000 metre buffers). For buffers of 800 metres, male and female Māori and Pacific Island people had higher odds of frequent consumption when living in neighbourhoods with seven or more outlets, compared to those living in neighbourhoods with no outlets. Similarly, younger Māori and Pacific Island females, aged 25–34, were more likely to be frequent consumers if they lived in areas with many outlets within a radius of three kilometres. Māori and Pacific Island people are more likely to be influenced by 'place' features, given that they had the highest rates of adverse consumption.

Two particular results stand out for Europeans. First, once individual characteristics and contextual variables had been controlled for, young European females (15–24 years) living in neighbourhoods that had seven or more outlets within walking distance had increased odds of hazardous alcohol consumption. Secondly, male Europeans aged 55–64 had higher odds of frequent consumption with increasing density of alcohol outlets within a three kilometre radius. There were slightly more significant results when density measures were used as they capture a wide catchment area, as opposed to distance measures which were concentrated within meshblocks.

While urban areas did not present any significant finding, the results in rural areas showed that while women were more likely to consume frequently or hazardously when residing closer to alcohol outlets, results for males were significant but in the opposite positive direction. Males have increased odds of frequent or hazardous consumption as distance increased. For buffers of 800 metres, females in rural areas living in areas with higher density of alcohol outlets within walking distance had higher odds of hazardous consumption, while all rural dwellers (both males and females combined) had a positive association indicating that as density increased consumption decreased. For frequent consumption both rural males and females had a positive association within both 800 and 3000 metres, where as density increased frequent consumption increased.

All these results described above were significant after controlling for both socio-demographics and area level factors and suggest that alcohol-related behaviour for these sub-populations was not an artefact of compositional factors. There are some results (e.g. Tables 7.21, 7.22, 7.23, 7.24, 7.25 and 7.29) that were significant at the $p<0.001$ level. Peres et al., (1999) suggested that in cases of multiple inferences, the alpha value should be increased to 99%. Additionally the literature reviewed earlier pointed to certain sub-populations as having strong neighbourhood effects, such as younger people in minority ethnic groups and younger women. Moreover, these groups were the heaviest consumers of alcohol (NZHS 2006/07), therefore their significant result is not by chance but has been shown in other studies. Additionally, studies in New Zealand have shown that greater alcohol availability and access is apparent in deprived neighbourhoods (Hay et al., 2009, Pearce et al., 2008a). The density of alcohol outlets has been observed to have an effect on heavy consumption amongst 12-17 year olds in Auckland, where the youth were mostly residing in deprived areas (Huckle et al,. 2008). Many of these most deprived neighbourhoods are inhabited by Māori or Pacific Island people, suggesting a link between the two factors. More analysis was therefore undertaken for young and ethnic minority groups, with significant results observed. Suffice to say, however, that some results were surprising, for example, significant results amongst non-Māori age 55-64, who were likely to consume alcohol when living in areas with a higher density of alcohol outlets. Such a result had not been expected on the basis of the literature reviewed.

The discussion in Chapter 9, will examine each of the significant results independently by examining reasons why ‘place’ features were important for the different sub-groups, beginning with young male Māori and Pacific Island people aged 15–24. Reasons for non-significant results amongst younger female Māori and Pacific Island and Europeans males aged 15–24 will be highlighted. The discussion will then focus on other sub-groups including European females aged 15–24, Māori and Pacific Island females aged 25–34 and 45–54, European males aged 55-–64, rural males and females, and older males aged 75 and over.

7.9 Conclusion

This study is the first to examine the relationship between distance and alcohol consumption at a national level. More importantly, research questions on whether 'place' influence behaviours are answered. After controlling for a range of potentially confounding variables it was found that there was a demonstrated association of some sub-populations' alcohol-related behaviour, especially Māori and Pacific Island people, with proximity to alcohol outlets. Incidentally this sub-population has the heaviest alcohol consumption in New Zealand and was more likely to live in deprived areas. There is emerging evidence that access to a variety of community resources, including alcohol outlets, is related to hazardous alcohol consumption and helps to explain the spatial and social patterning of health outcomes (Huckle et al., 2008)

The next chapter examines the relationship between density and alcohol related impacts.

Chapter 8 Alcohol-related impacts: Relationship between alcohol outlets and hospitalisation and crime.

The previous chapter examined how access measures are related to consumption using binary logistic regression modelling and showed that some groups living near alcohol outlets were at higher odds of hazardous alcohol consumption. Since ‘place’ had an effect on consumption, this chapter examines two alcohol-related impacts and how they are associated with proximity to alcohol outlets. The two impacts are hospitalisation and crime. Section 8.1 will examine the relationship between proximity to alcohol outlets and hospitalisation while section 8.4 will focus on crime.

8.1 Alcohol outlets and hospitalisation

This research examines the relationship between the density of alcohol outlets and hospitalisation rates. Earlier results in Chapter 5 had indicated that both the density of alcohol outlets and rates of hospitalisation were higher in deprived areas. Therefore, this research examines the potential relationship between these variables. Other studies (e.g. Tatlow et al., 2001) have shown that access to alcohol outlets as a proxy for consumption also predicts hospitalisation for alcohol-related causes, but international and New Zealand-based studies exploring such relationships are limited. For this part of the chapter the main question to be answered is:

- Does ease of access to alcohol outlets and their density in the local area have a relationship with alcohol-related hospitalisation after controlling for a range of population and ‘place’ characteristics?

To answer this question, the relationship between hospitalisation rates for alcohol-related diseases and density of alcohol outlets, stratified by type and category will be examined.

8.1.1 Description of data

As indicated in Chapter 4, this study uses OLS regression, with standardised rates of hospitalisation as the dependent variable, and all alcohol outlets, stratified by type (on and off license) and sometimes category (Supermarkets/general stores/dairies, bottle stores, hotels/taverns/pubs) as the independent variables.

Hospitalisation data are confined to those cases most directly associated with alcohol consumption, including cirrhosis of the liver, pancreatitis, and intoxication, amongst others. Other causes of hospitalisation attributed to alcohol or shown to have a causal relationship with it (e.g. cancers of the mouth, oesophagus, some traffic and other accidents) have been excluded (Rehm et al., 2003b). As shown in Chapter 4, Similar ICD codes have been used in studies in United Kingdom (Harrison and Gardiner, 1999, Breakwell et al., 2007) and Russia (Pridemore and Kim, 2006). The results described in Chapter 5 identified hospitalisations as a good proxy of alcohol consumption, without necessarily considering time lags for diseases.

As discussed in Chapter 4 standardised rates of hospitalisation were calculated for all CAUs. To examine whether the relationship between age-standardised rates of hospitalisation and the density of alcohol outlets was independent of other confounding variables, a series of control variables were identified, including a range of population and 'place' characteristics, which have a relationship with hospitalisation. Such characteristics include: the percentage of households headed by single parents, the proportion of adults aged 15-24 and 65 years and over, the percentage of adult males aged 15 years and over, ethnicity data (proportion of Māori) and area deprivation. These are control variables that are associated with alcohol-related hospitalisation and excess consumption, the latter being a risk factor for hospitalisation (Tatlow et al., 2000, Gruenewald et al., 2006). In Chapter 5, the results on age-standardised rates of hospitalisation also indicated that many young people (15-24), and older people (65 and above) as well as Māori and those living in deprived and urban areas had higher hospitalisation rates than all the other groups, so these were also selected as control variables. Access measures were used at smaller geographical level. as hospitalisation data could only be linked to domicile codes and CAUs, using measures of access at such a broad geographical level was considered unreliable. Density of alcohol outlets was therefore used.

The analysis was undertaken in three steps. The first involved investigating the relationship between the standardised rates of hospitalisation and the density of alcohol outlets. Correlation and regression analyses were undertaken on age-standardised rates and alcohol outlet density variables, without any controls. The second step was to examine whether the control variables were inter-related or collinear, and to choose the most appropriate variables. Step three was a complete regression analysis with age-standardised rates of hospitalisation as dependent variable and alcohol outlets as explanatory variable, after controlling for confounding variables.

8.1.2 Analytical approach

In the first step, correlation analysis was undertaken between the dependent variable (age-standardised rates of hospitalisation) and explanatory variables (density of alcohol outlets) for the whole of New Zealand as well as urban and rural areas. Correlation between standardised hospitalisation rates and alcohol outlet density by type and category indicates that alcohol outlets have a weak but positive relationship with age-standardised rates of hospitalisation, showing an increase in hospitalisation in areas of high outlet densities (Table 8.1).

Table 8.1: Simple correlation between hospitalisation rates and alcohol outlets.

	Age-Standardised rates of hospitalisation	All outlets	On-licences	Off-licences	Supermarket/ general stores/dairies
All outlets	0.34**				
On-licences	0.39**	0.90**			
Off-licences	0.32**	.092**	0.77**		
Supermarkets/ general stores/dairies	*0.27***	*0.68***	*0.62***	*0.73***	
Bottle stores	*0.29***	*0.66***	*0.53***	*0.74***	*0.39***
Hotels, taverns, bars	0.37**	0.97**	0.87**	0.62**	0.55**

***** Correlation is significant at the 0.01 level (2-tailed).***

Hotels, taverns, bars have a strong positive association (0.87) with on-licences and since each of the three categories were very similar they were omitted from further analysis. However, for off-licences, each of the categories (supermarkets/general stores/dairies and bottle stores) had slightly different characteristics and were retained for further analysis. Consequently, regression analysis was undertaken for standardised rates of hospitalisation with all alcohol outlets as explanatory variables to examine whether the overall relationship remained.

Initial OLS regression analysis (results not shown) of all types of alcohol outlets independently, showed that the predicted variance in hospitalisation rates varied from 15% for on-licences to 10% for off-licences. When further stratified by the off-licence categories of bottle stores and supermarkets/general stores/dairies, the explained variance in hospitalisation predicted was 8.2% and 7.4% respectively. Before controlling for a range of population and ‘place’ characteristics, alcohol outlets alone were predictors of hospitalisation; however, the hospitalisation variance predicted was low indicating that some important variables were missing from the regression analysis.

To observe whether the relationship was maintained, despite obvious multi-collinearity (meaning that the affected estimates were unstable and had high standard errors) since alcohol outlets have strong relationships with each other, a regression analysis was undertaken for all the alcohol outlet variables together. Two models were run, one with only the type of outlets (results not shown) and the second with type and categories of off-licences (supermarkets/ general stores/dairies and bottle stores) (Table 8.2).

Table 8.2: Regression results for standardised rates of hospitalisation per 10 000 and all alcohol outlets:

Variables	**Standardized Coefficients**	**p value**	**R^2 = 0.166**
(Constant)		0.000	
On-licences	0.356	0.000	
Off-licences	-0.159	0.003	
Supermarkets/ general stores/dairies	0.101	0.004	
Bottle stores	0.177	0.000	

While the model for on- and off-licenses predicted 15.1 % of the variance (result not shown), this increased to 16.6% when the two off-licence categories were added (Table 8.2). The regression coefficient for total off-licences changed from positive to negative with the addition of the two independent categories, because of collinearity.

In summary, despite multi-collinearity, the results indicate that there was a relationship between hospitalisation and all alcohol outlets. This relationship remained whether each type or category was regressed separately (results not shown) or together (Table 8.2). The next step was to determine whether this relationship between hospitalisation and outlets remained, after controlling for population and 'place' characteristics.

The relationship between the control variables was also investigated in order to avoid biased estimates or multi-collinearity. The control variables were subjected to correlation as well as collinear tests. For the control variables, the initial results (Appendix 52) indicated that while some relationships between the control variables were weakly correlated, other relationships were strongly positive. The relationship between the proportion of Māori in the population and area deprivation on one hand (0.46), and the percentage of households headed by a single parent (0.67), on the other hand, were strong and positive. There was a strong positive correlation between the percentage of households headed by single parents and area deprivation (0.59), and also between the former and proportion of adults 65 years and over (0.45). The analysis for urban and rural areas produced similar results to the whole of New Zealand highlighted above, although the values were different (Appendix 53 and 54).

All control variables were then regressed as a block (Spicer, 2005) based on the theory that they predict hospitalisation rates (Gruenewald et al., 2006, Tatlow et al., 2000). Results in Chapter 5 suggested that younger age groups (15-24), older age groups (65 and over), Māori, and those living in urban and deprived areas were more likely to be hospitalised. The hospitalisation variance predicted by the control variables was 21.6%. Since the control variables were correlated, this result was a biased estimate and therefore tests for collinearity were undertaken. These revealed a high condition index (over 30) and large variance inflation factor (VIF) values meaning that the variables have a strong relationship with each other (Myers, 1986). Consequently, further tests were undertaken to determine which variables were contributing to these high values. The results indicated that the percentage of males aged 15 years and over had a strong relationship with all the other variables (See Appendix 55); therefore, this variable (percentage of males aged 15 years and over) was removed from the regression. The final control variables used include the percentage of households headed by single parents, area deprivation, percentage of adults aged 15-24, aged 65 and above, and percentage of Māori population.

After choosing and vetting the control variables, the third step was to examine the relationship between alcohol outlets and hospitalisation rates using OLS regression, while controlling for population and 'place' characteristics. All control variables were entered as a block in the regression analyses, before adding the different measures of alcohol outlet density (Spicer, 2005, Virtanen et al., 2007). The models are presented in three ways. The first model is for all alcohol outlets in New Zealand, followed by location (separate models for urban and rural areas) and finally on-licence and off-licence categories in the same locations.

8.2 Results

8.2.1 Influence of all alcohol outlets on hospitalisation

Table 8.3 presents the result of the first model. After adding all control variables, the density of total alcohol outlets was statistically significant ($p < 0.001$) and predicted 9% of explained variance in hospitalisation rates, almost one third of the total variance explained. In total, the alcohol outlet density and control variables predicted 29.8% of explained variance in hospitalisation nationally. The unstandardised beta coefficient (not shown) indicates that for every unit increase in total alcohol outlets, hospitalisation rates per 100 000 increased by 0.83. Additionally, all control variables were significant ($p < 0.05$).

The analysis for urban areas showed that all alcohol outlets were significantly associated with hospitalisation rates after adding all the control variables. Alcohol outlets predicted 11% of explained variance in hospitalisation rates with a total cumulative explained variance of 30.5%, indicating that alcohol outlets predicted almost a third of the total explained variance in hospitalisation. For rural areas total alcohol outlets alone only predicted 2.8% of the variance, which was expected because of the low rates of hospitalisations in these areas.

All the control variables were significant ($p < 0.05$) both nationally and in urban areas (except for percentage Māori). For rural areas, only the percentages of households headed by single parents, adults aged 15-24 and 65 years and above were significant in regression. This result was not surprising considering that urban areas have more outlets, especially in deprived areas.

Table 8.3: Regression results for age-standardised rates of hospitalisation and density of total alcohol outlets while controlling for confounding variables

Location	Variables	Standardized Coefficients	p-value	R^2	Net R^2 due to density variable
New Zealand	(Constant)		0.000		
	% single parents	0.324	0.000		
	NZ deprivation	0.053	0.046		
	% 65 years and over	0.116	0.000		
	% 15-24	0.183	0.000		
	% Māori pop	-0.036	0.205	0.204	
	All alcohol outlets	**0.311**	**0.000**	**0.298**	**0.094**
Urban	(Constant)		0.007		
	% single parents	0.288	0.000		
	NZ deprivation	0.077	0.014		
	% 65 years and over	0.089	0.001		
	% 15-24	0.179	0.000		
	% Māori pop	-0.021	0.533	0.193	
	All alcohol outlets	**0.340**	**0.000**	**0.305**	**0.112**
Rural	(Constant)		0.113		
	% single parents	0.326	0.000		
	NZ deprivation	-0.001	0.991		
	% 65 years and over	0.213	0.000		
	% 15-24	0.104	0.035		
	% Māori pop	-0.009	0.900	0.175	
	All alcohol outlets	**0.136**	**0.000**	**0.202**	**0.028**

Dependent Variable: Age-Standardised rates of hospitalisation

Bold shows main study factor (density of alcohol outlets)

In summary, the total density of alcohol outlets variable remained significant even after adding control variables and predicted a third of the total explained variance in hospitalisation at the national level and in urban areas. The density of alcohol outlets was, therefore, a good predictor of hospitalisation both nationally, and in urban areas. However, the results also indicate that the residuals are very high, suggesting that some important explanatory variables, such as personal income, education level and occupational status, are missing.

8.2.2 Influence of outlet type on hospitalisation: on- and off-licences

More analysis was performed to see if the type of alcohol outlet predicted hospitalisation after controlling for confounders. As illustrated in Chapter 6 the rates and distribution of alcohol outlets varied by type in different areas as did the rates of hospitalisation; therefore, examining the relationship between the two would highlight the extent to which different types of outlets make a difference in predicting hospitalisation. The analysis in Chapter 7 did not separate outlets by type because of data confidentiality constraints, so there was no indication of the way different outlets contributed to alcohol behaviour. Examining the relationship between the two (type of outlets and hospitalisation) is important because studies have indicated that separating outlets by type and category might identify which contributes more to the burden of hospitalisation (Gruenewald et al., 2006). On-licences are premises where alcohol is bought and consumed and intoxicated patrons can be removed by security, at security's discretion (Graham et al., 2005). For off-licences, there is no control over the amount that can be purchased or consumed (Galloway et al., 2007).

At the national level, Table 8.4 shows that the density of on-licensed premises was significant after adding all the control variables. Approximately a third of the total explained variance in hospitalisation was predicted by on-licences, after controlling for a range of variables including deprivation. Density of on-licences predicted 11.6% of the variance in hospitalisation compared to 20.4% for control variables, for a cumulative R^2 of 0.32. For every unit increase in on-licensed premises hospitalisation rates increased by 1.55 people per 100 000.

The results for urban areas were akin to those for New Zealand as a whole, with approximately half (14.2) of the explained variance in hospitalisation rates predicted by the density of alcohol outlets. In urban areas the density of alcohol outlets predicted a slightly higher variance in hospitalisation than at national level. While density of outlets at national level predicted only a third of total variance explained, the density of alcohol outlets in urban areas predicted slightly less than 50% of the total explained variance in hospitalisation rates. For every unit increase in on-licences, hospitalisation rates increased by 1.6 people per 100 000.

For rural areas, after controlling for confounders, the density of on-licences and control variables predicted 19% of the variance in hospitalisation, increasing by 3% when on-licences were added to the model. For every unit increase in the density of on-licences, hospitalisation increased by 0.92 people per 100 000.

Not surprisingly, the regression coefficient for deprivation was negative and not significant in rural areas, while it was both positive and significant in urban areas. This indicates that in urban areas, as deprivation increases so does hospitalisation. Earlier analysis has shown that alcohol outlets in urban areas were mostly located in deprived areas, a result not consistent with the rural areas especially when classified into four rural categories (remote, with high, moderate and low urban influence). Most importantly there was a relationship between the density of on-licences and hospitalisation rates in both urban and rural areas, even though these relationships run in different directions.

Table 8.5 shows the analysis of whether the density of off-licensed premises predicts hospitalisation. As with the trends observed earlier, at the national level, the density of off-licences was significant after adding control variables. The density of off-licences explained 7.7% of the total explained variance in hospitalisation with control variables explaining 20.4% for a cumulative hospitalisation variance of 28.1%, indicating that off-licences predicted a quarter of the total explained variance.

For urban areas, the explained variance in hospitalisation was slightly higher than for the whole country. Control variables predicted 19.3% of the variance in hospitalisation with off-licence density predicting 8.7%, of the same for a cumulative total of 28.0%. In rural areas explained variance in hospitalisation increased from 17.5% to 21.4%, when the density of off-licenses were added to the regression, indicating that they (the density of off-licences) alone increased the explained variance in hospitalisation by only 4%.

Table 8.4: Regression results for standardised rates of hospitalisation and the density of on-licence premises while controlling for confounding variables

Location	Variables	Standardized Coefficients	p-value	R^2	Net R^2 due to density variable
New Zealand	(Constant)		0.001		
	% single parents	0.325	0.000		
	NZ deprivation	0.049	0.061		
	% 65 years and over	0.109	0.000		
	% 15-24	0.161	0.000		
	% Māori pop	-0.033	0.239	0.204	
	On-license	**0.347**	**0.000**	**0.320**	**0.116**
Urban	(Constant)		0.093		
	% single parents	0.288	0.000		
	NZ deprivation	0.077	0.012		
	% 65 years and over	0.075	0.004		
	% 15-24	0.148	0.000		
	% Māori pop	-0.023	0.473	0.193	
	On-license	**0.386**	**0.000**	**0.335**	**0.142**
Rural	(Constant)		0.093		
	% single parents	0.323	0.000		
	NZ deprivation	-0.006	0.916		
	% 65 years and over	0.226	0.000		
	% 15-24	0.111	0.026		
	% Māori pop	0.002	0.982	0.175	
	On-license	**0.172**	**0.000**	**0.199**	**0.029**

Dependent Variable: Age-Standardised rates of hospitalisation

Bold shows main study factor (density of alcohol outlets)

Table 8.5: Regression results for standardised rates of hospitalisation and the density of off-licensed premises while controlling for confounding variables

Location	Variables	Standardized Coefficients	p-value	R^2	Net R^2 due to density variable
New Zealand	(Constant)		0.000		
	% single parents	0.309	0.000		
	NZ deprivation	0.059	0.029		
	% 65 years and over	0.109	0.000		
	% 15-24	0.201	0.000		
	% Māori pop	-0.037	0.202	0.204	
	Off-license	**0.283**	**0.000**	**0.281**	**0.077**
Urban	(Constant)		0.003		
	% single parents	0.269	0.000		
	NZ deprivation	0.084	0.008		
	% 65 years and over	0.089	0.001		
	% 15-24	0.198	0.000		
	% Māori pop	-0.013	0.706	0.193	
	Off-license	**0.300**	**0.000**	**0.280**	**0.087**
Rural	(Constant)		0.242		
	% single parents	0.301	0.000		
	NZ deprivation	-0.002	0.971		
	% 65 years and over	0.169	0.001		
	% 15-24	0.100	0.042		
	% Māori pop	-0.002	0.976	0.175	
	Off-license	**0.261**	**0.000**	**0.214**	**0.039**

Dependent Variable: Age-Standardised rates of hospitalisation

Bold shows main study factor (density of alcohol outlets)

At national level and in urban areas, all control variables were significant except for the percentage of Māori population. For rural areas, neither area deprivation nor percentage of Māori population was significant.

In comparing urban and rural areas, the explained variance in hospitalisation predicted by on-licences and off-licences was higher in urban than rural areas. A comparison of on- and off-licences shows that on-licence density predicted the highest variance in hospitalisation in urban areas at 14.2% (almost half the total explained variance) compared to 8.7% for off-licences (a quarter of the total variance explained). For rural areas, the highest variance in hospitalisation was predicted by off-licences which explained 4.4% of the variance compared to on-licences which explained only 2.9%, both small proportions of the total explained variance in hospitalisation rates.

8.2.3 Influence of off-licence categories on hospitalisation rates

Analysis was undertaken to investigate the two categories of off-licences (supermarkets/general stores/dairies and bottle stores) and whether they also influenced hospitalisation (Table 8.6). The density of the off-licences category was chosen, but not on-licences. This was because most hotels, taverns, and bars would present similar results to the on-licence type since the individual categories have a strong positive correlation (0.87 (See Table 8.1 for correlation results)). The two categories of outlets are important because studies have shown that the change in legislation in New Zealand in 1989, which allowed wine sales in supermarkets, resulted in alcohol consumption increasing by 18% as well as alcohol sales in outlets that previously were not licensed (Huckle et al., 2006). Neither liquor stores nor supermarkets have any control over the amount of alcohol that can be purchased. Excess consumption from off-licences has been associated with hospitalisation rates for injury, especially amongst Pacific Island people and young people (Huakau et al., 2005).

For New Zealand as a whole, after controlling for confounding factors, the density of supermarkets/ general stores/dairies was significant and explains 6% (almost 20% the total explained variance) of the variance in hospitalisation for a cumulative R^2 of 26% (Table 8.6). All control variables were significant ($p < 0.05$) including the percentage of

Table 8.6: Regression results for standardised rates of hospitalisation and the density of supermarkets/ general stores/dairies while controlling for confounding variables

Location	Variables	Standardized Coefficients	p-value	R^2	Net R^2 due to density variable
New Zealand	(Constant)		0.000		
	% single parents	0.327	0.000		
	NZ deprivation	0.077	0.005		
	% 65 years and over	0.096	0.000		
	% 15-24	0.189	0.000		
	% Māori pop	-0.066	0.025	0.204	
	Supermarkets/ general stores/dairies	**0.243**	**0.000**	**0.263**	**0.059**
Urban	(Constant)		0.004		
	% single parents	0.295	0.000		
	NZ deprivation	0.089	0.005		
	% 65 years and over	0.074	0.005		
	% 15-24	0.189	0.000		
	% Māori pop	-0.038	0.253	0.193	
	Supermarkets/ general stores/dairies	**0.303**	**0.000**	**0.282**	**0.089**
Rural	(Constant)		0.316		
	% single parents	0.318	0.000		
	NZ deprivation	0.038	0.514		
	% 65 years and over	0.208	0.000		
	% 15-24	0.076	0.129		
	% Māori pop	-0.031	0.678	0.175	
	Supermarkets/ general stores/dairies	**0.096**	**0.049**	**0.181**	**0.006**

Dependent Variable: Age-Standardised rates of hospitalisation

Bold shows main study factor (density of alcohol outlets)

Māori population, which was not significant in earlier analysis for the density of on- and off-licence.

When urban and rural, areas were considered separately, the density of supermarkets/general stores/dairies and control variables predicts 28% (urban) and 18% (rural) of the total explained variance in hospitalisation. The variance explained by the density of supermarkets/general stores/dairies alone also varied from 9% in the urban areas to less than 1% in the rural areas. For urban areas all control variables were also significant, except for the proportion of Māori within the population, while only two control variables were significant in rural areas.

Table 8.7 illustrates that bottle stores predicted 4.7% compared to 25.1 % total explained variance in hospitalisation after adding all control variables. This indicates that bottle stores predicted some (about 20%) of the total explained variance in hospitalisation rates at the national level. In urban areas the variance in hospitalisation rates predicted by bottle stores was 6.1%, predicting some (almost 20%) of the total explained variance in hospitalisation rates. Bottle stores were not significant in rural areas. The earlier results in Chapter 6 showed differences between urban and rural areas, with comparatively fewer bottle stores in remote areas and rural areas with high urban influence.

Table 8.7: Regression results for standardised rates of hospitalisation and the density of bottle stores while controlling for confounding variables

Location	Variables	Standardized Coefficients	p-value	R^2	Net R^2 due to density variable
New Zealand	(Constant)		0.000		
	% single parents	0.265	0.000		
	NZ deprivation	0.094	0.001		
	% 65 years and over	0.182	0.000		
	% 15-24	-0.009	0.000		
	% Māori pop	0.265	0.759	0.204	
	Bottle stores	**0.221**	**0.000**	**0.251**	**0.047**
Urban	(Constant)		0.002		
	% single parents	0.245	0.000		
	NZ deprivation	0.096	0.003		
	% 65 years and over	0.108	0.000		
	% 15-24	0.204	0.000		
	% Māori pop	0.009	0.799	0.193	
	Bottle/Stores	**0.251**	**0.000**	**0.253**	**0.060**
Rural	(Constant)		0.164		
	% single parents	0.318	0.000		
	NZ deprivation	0.047	0.425		
	% 65 years and over	0.251	0.000		
	% 15-24	0.085	0.088		
	% Māori pop	-0.024	0.744	0.175	
	Bottle/Stores	**-0.010**	**0.829**	**0.181**	**0.006**

Dependent Variable: Age-Standardised rates of hospitalisation

Bold shows main study factor (density of alcohol outlets)

8.3 Summary of results

Three major themes emerged from this analysis. The density of alcohol outlets, by type or category, is a predictor of hospitalisation after controlling for a range of confounders. This study found that all alcohol outlets, by type and category predicted varying proportions of the total explained variance ranging from almost 20% to a half.

Starting with all alcohol outlets, this study found that all alcohol outlets combined predicted almost a third of the total explained variance in hospitalisation rates. Consequently, when the alcohol outlets were separated by different categories and type, this study revealed that these variables predict the rates of hospitalisation. On-licensed premises predicted 11.6% and 14.2% (almost a third of the total explained variance) variance in hospitalisation for both New Zealand as a whole and for urban areas respectively. Similarly for these same two areas, off-licences predicted 7.7% and 8.7% of explained variance in hospitalisation respectively (almost a quarter of the total explained variance). When the analysis was further stratified by the density of supermarkets/ general stores/dairies, they predicted 5.9% and 8.9% of explained variance in hospitalisation in the whole of New Zealand and in urban areas respectively (almost 20% of the total explained variance). The density of bottle stores explained 4.7% and 6% of the variance in hospitalisation rates for similar areas. The explained variance in hospitalisation for rural areas was less than 1% for both supermarkets and bottle stores, even though the results for bottle stores were not significant.

The second major finding is that the relationships between hospitalisation and alcohol outlets vary significantly between urban and rural areas. Of all the significant variables, the density of alcohol outlets predicts a bigger portion of explained variance in hospitalisation in urban areas compared to the rural areas. The urban model for all alcohol outlets predicted 30.5% of total explained hospitalisation variance, which was the highest compared to the whole of New Zealand (29.8%) and rural (19.8%). While the urban areas generally followed the national trend, the rural areas were different. In urban areas, after controlling for a range of factors, including deprivation, the number of off-licences and on-licences were significant predictors of hospitalisation.

The third major finding is that those living in deprived areas with many alcohol outlets, single parents, older people (65 and above) and those aged 15-24 were more likely to be hospitalised for alcohol-related disease. The earlier results in Chapter 5 also indicated that people of similar socio-demographics were more likely to be hospitalised. Earlier analysis (Chapter 5) using Poisson regression had also indicated that after controlling for a range of 'place' and individual characteristics that there was an increase in hospitalisation rates in poor areas, but a decrease in affluent areas.

Most importantly, this analysis was able to show that density of alcohol outlets explained some portion of the explained variance in hospitalisation rates after controlling for confounding factors. Explanations for the above observations will be undertaken in Chapter 9. This is the first study to be undertaken in New Zealand to establish the relationship between alcohol outlets and hospital admissions and it has suggested that 'place' features measured by the density of alcohol outlets at CAU level predict alcohol-related hospitalisation, a factor previously ignored by other studies. These results are important in understanding the effect of 'place' on hospitalisation; however, there are other individual and 'place' factors that are also important, given the low variance and residuals estimated. The next section discusses the second impact, the relationship between alcohol outlets and crime.

8.4 Alcohol Outlets and crime

The previous section showed that after controlling for a range of population and place characteristics, there was a relationship between the density of alcohol outlets and alcohol-related hospitalisation. The initial literature review in Chapter 2 suggested that there is also a relationship between the density of alcohol outlets and crime. Crime is one social impact that has generated a lot of interest in New Zealand (Cameron 2010, Law Commission, 2009, Wood, 2005). The ALAC reports that understanding how crime relates to alcohol outlets could lead to interventions that could save almost NZ$250 million a year and which is currently used in solving crime related to alcohol consumption. Since 75–90% of weekend crime is attributed to alcohol, appropriate interventions could considerably reduce this rate (Wood, 2005). This study is timely since the Drug policy 2007-2012 and the Law Review Commission, headed by Sir Geoffrey Palmer, both mention crime and alcohol as major priorities for New Zealand (Law Commission, 2009).

Initial studies concentrated on the relationship between individual consumption and crime (Fergusson et al., 1996, Fergusson and Horwood, 2000). As with other health studies, most researchers suggested that individual factors and the amount of alcohol consumed do not fully explain the variation and there must be some contextual factors influencing crime, especially with the literature showing that alcohol outlets appear to attract crime (Roman et al., 2008). More recently, a study conducted in one small geographic area in Auckland indicated that increased density of alcohol outlets was associated with higher crime rates (Cameron et al., 2010).

The aim of this section is to determine whether the density of alcohol outlets have an effect on crime after controlling for potential confounding factors whether individual, population-related or area level. The analysis was undertaken in three sub-sections. The first was to examine the relationship between crime and control variables and then select appropriate control variables after collinearity tests. Secondly, regression analysis was then performed for all alcohol outlets together and crime, and finally, to establish whether or not there was a relationship between the density of alcohol outlets and crime after controlling for confounders.

The frequency distribution in Table 8.8 shows that both serious and minor crimes were committed in dwellings, or on or alongside roads, relatively fewer crimes were committed at licensed premises or other areas

Table 8.8: Total violent crime for three years (2005-2007) by place where crime occurred

	Serious violent crime		**Minor violent crime**	
Place where crime occurred	**Total number**	**Percentage**	**Total number**	**Percentage**
Dwelling	32 191	45.3	37 673	54.3
Licensed Premises	3 135	4.4	2 997	4.3
Road	31 212	43.9	24 519	35.3
Other places	4 525	6.4	4 211	6.1
Total	**72 170**	**100**	**69 400**	**100**

As in the previous hospitalisation analysis, control variables were chosen based on indications from the literature that there was a relationship between crime and some population and 'place' characteristics, and that these factors may confound the relationship between outlets and crime (Gruenewald et al., 2006). These variables were; percentage of households headed by single parents; area deprivation; proportion of adults aged 15 years and over; proportion of young people aged 15-24; proportion of the population unemployed; and the percentage of Māori within the TAs. These control variables were all derived from the 2006 census and the proportions were calculated based on the total population of adults (15 years and over) in each TA. See Chapter 4 for details of the data as well as control variables and how they were chosen or derived. After choosing the control variables, a correlation analysis was undertaken.

8.4.1 Relationship of crime to control variables

The first step was to examine the correlation between crime and the control variables, see Table 8.9. While there were some significant correlations between serious violent crime occurring in different places with some control variables, for example, percentage Māori and serious violent crime occurring at other places (0.39), the correlations were relatively weak when compared to minor crime. Minor violent crimes occurring in dwellings, licensed premises, public and other places had a relationship with relatively more control variables than did serious violent crime occurring in the same places. A comparison of crime occurring in dwellings for serious and minor violent crime showed that, while the former had a relationship with only two control variables, the latter had a relationship with four control variables. Minor violent crime occurring in dwellings was positively correlated to unemployment rates (0.72), percentage Māori (0.64) and deprivation quintiles (0.64), while it was negatively correlated to percentage adults (-0.62).

Table 8.9: Simple correlation between violent crime rates and control variables

Control variables	Dwelling	Licensed Premises	Public/Roads	Other	Total
	Serious violent crime by place of occurrence				
% Unemployed	0.32**	-0.09	0.27*	0.25*	0.32**
% 15-24	-0.01	-0.08	0.16	0.15	0.07
% Māori	0.22	0.21	0.06	0.39**	0.26*
% Males	-0.22	0.23*	-0.33**	-0.06	-0.23
% adults	-0.26*	-0.00	0.04	-0.29*	-0.18
Area deprivation	0.26*	0.01	0.21	0.24*	0.28*
	Minor violent crime by place of occurrence				
% Unemployed	0.72**	-0.10	0.47**	0.32**	0.70**
% 15-24	0.17	-0.08	0.30*	0.17	0.24*
% Māori	0.64**	0.19	0.22	0.48**	0.63**
% Males	-0.19	0.21	-0.41**	-0.06	-0.25*
% adults	-0.62**	0.05	-0.06	-0.33**	-0.51**
Area deprivation	0.64**	0.04	0.37**	0.31**	0.63**

Significant ** (ρ= <0.01) * (ρ <0.05)

The next step was to examine whether the control variables had a relationship with each other and whether or not collinearity existed, and then to choose the most appropriate variables. In the correlation analysis, the control variable, unemployment rate, had a strong positive or negative correlation with all the other control variables (See Appendix 56). The variable, percentage of Māori, had a strong negative correlation with the percentage of adults, and a strong positive correlation with deprivation. Since some of the variables were highly correlated, further collinearity tests were undertaken to choose the most appropriate variables to remove bias in the estimation.

Further collinearity tests indicated that the Eigen values were close to zero for some control variables and high VIF (Myers, 1986). Condition index was over 15, which meant that the variables are highly correlated and therefore collinear suggesting that the variables have a strong relationship with each other (Myers, 1986) (See Appendix

57). More collinearity tests were undertaken by examining the components which had the high condition index and contributed substantially to the variance of three or more variables (Myers, 1986). These two variables (percentage male and percentage adult) were contributing to the variance of three or more variables and were therefore excluded from the analysis. Additionally, collinearity tests were undertaken with the remaining four variables. These revealed that the variable, percentage of people unemployed, also contributed substantially to the variance of two or more variables and was excluded from the analysis. The percentage of people unemployed is one of the variables used in the New Zealand area deprivation index and is therefore strongly correlated to deprivation. The final control model consisted of three control variables.

All of these control variables were then entered as block to explain crime occurring in different places.

8.4.2 Density of alcohol outlets and crime

As with the previous analysis on hospitalisation, the first step was to examine the relationship between crime and alcohol outlets.

Table 8.10 illustrates the correlation between both serious and minor violent crime and alcohol outlets. The relationship varies as different types and categories of alcohol outlets had a relationship with crime occurring at certain places. Starting with serious violent crime, the density of total alcohol outlets had a positive relationship with serious violent crime occurring at licensed premises (0.32). The density of off-licensed premises had a positive relationship with serious violent crime occurring at these premises (0.29) and a negative relationship (-0.25) with serious violent crime occurring in public places, such as the road side.

Table 8.10: Simple correlation between violent crime rates and the density of alcohol outlets

Alcohol outlets	Dwelling	Licensed Premises	Public/Roads	Other	Total crime
	Serious violent crime by place of occurrence				
Total outlets	-0.22	0.32**	-0.20	-0.07	-0.16
Off-licenses	-0.19	0.29*	-0.25*	-0.05	-0.17
On-licenses	-0.24*	0.32**	-0.13	-0.08	-0.14
Bottle stores	0.16	0.05	0.14	0.01	0.16
Supermarkets/general stores/dairies	-0.19	0.22	-0.28*	-0.06	-0.19
Hotels/Taverns/Bar	-0.25*	0.33**	-0.20	-0.07	-0.17
	Minor violent crime by place of occurrence				
Total outlets	-0.27*	0.41**	-0.27*	-0.12	-0.25*
Off-licenses	-0.25*	0.37**	-0.31**	-0.10	-0.24*
On-licenses	-0.28*	0.43**	-0.21	-0.12	-0.23
Bottle stores	0.10	0.07	0.21	0.02	0.15
Supermarkets/general stores/dairies	-0.19	0.28*	-0.27*	-0.11	-0.20
Hotels/Taverns/Bar	-0.30*	0.42**	-0.30*	-0.12	-0.27*

Significant ** (ρ <0.01) * (ρ <0.05)

As with serious violent crime, there was a negative association between crimes occurring at dwellings with the density of all alcohol outlets, whether they were off-licensed or on-licensed premises. This demonstrates that as minor violent crime occurring at dwellings increased, the number of outlets was fewer. For minor violent crime occurring at licensed premises the opposite was true with a positive relationship with all alcohol outlets other than bottle stores, indicating that increases in crime occurring at licensed premises were related to an increase in the density of all alcohol outlets, except for bottle stores.

After correlation, regression analysis was performed (without control variables) to examine the relationship between alcohol outlets and crime. As with the earlier hospitalisation analysis, this was to test whether the relationship found during correlation still held, and that the density of alcohol outlets was an independent predictor of minor and violent crime occurring at different places. Each of the alcohol outlets were entered as a block and analysed together in regression despite obvious collinearity. Only significant regression results are reported and R^2 indicated. Table 8.11 illustrates that for different crimes occurring at various places, it was crime occurring on roads or in public places that had a significant regression estimate ($p < 0.05$). The density of bottle stores was also significant ($p < 0.05$) for crime occurring on roads or in public places. Despite most outlets not being significant, they explained 12.1% of variance in public places and or road crime. This showed that even with the presence of other outlets, it was only bottle stores that best explained crime in public places or on roads.

Table 8.12 illustrates the regression results for all alcohol outlets and different places where minor violent crime occurred. Similar to serious crime, all alcohol outlets were entered as a block. Only significant regression results are reported and R^2 indicated. The density of alcohol outlets explained 13.6% of the variance in crime occurring at licensed premises; yet no single type or category of outlet had significant results despite the regression being significant ($p < 0.05$). For crime occurring at road sides, after controlling for all other outlets, the density of off-licences and bottle stores were significant and all the outlets explained 19.4% of the variance. As with serious violent crime, bottle stores explained crime occurring on roads or public places. In addition, off-licences also had significant results ($p < 0.05$). Having established that some alcohol outlets have an independent relationship with crime, the next step was to analyse whether this relationship remained after controlling for a range of confounding variables.

Table 8.11: Regression results for serious violent crime rates and the density of alcohol outlets

	Serious violent crime by place of occurrence									
	Dwellings		**Licensed Premises**		**Public/Roads*** $R^2 = 0.121$		**Other**		**Total (All crime combined)**	
Alcohol outlets	**Standardized Coefficients**	p **value**	**Standardized Coefficients**	p **value**	**Standardized Coefficients**	p **value**	**Standardized Coefficients**	p **value**	**Standardized Coefficients**	p **value**
Constant		0.000		0.052		0.000		0.000		0.000
Off-licenses	0.084	0.819	0.138	0.707	-0.600	0.092	0.184	0.633	-0.163	0.660
On-licenses	-0.261	0.290	0.277	0.263	0.442	0.065	-0.168	0.516	0.079	0.749
Bottle stores	0.210	0.099	-0.021	0.867	0.286	0.020	0.009	0.947	0.244	0.058
Supermarkets general stores/dairies	-0.125	0.619	-0.096	0.701	-0.143	0.554	-0.106	0.687	-0.171	0.500

* Significant $p<0.05$

Table 8.12: Regression results for minor violent crime rates and density of alcohol outlets

	Minor violent crime by place of occurrence									
	Dwellings		**Licensed Premises *** $R^2 = 0.136$		**Public/Roads*** $R^2 = 0.194$		**Other**		**Total**	
Alcohol outlets	**Standardized Coefficients**	**p value**	**Standardized Coefficients**	**p value**	**Standardized Coefficients**	**p value**	**Standardized Coefficients**	**p value**	**Standardized Coefficients**	**p value**
Constant		0.000		0.008		0.000		0.000		0.000
Off-licenses	-0.258	0.481	0.114	0.745	-0.915	0.008	0.184	0.633	-0.434	0.235
On-licenses	-0.172	0.485	0.416	0.080	0.425	0.064	-0.168	0.516	0.039	0.873
Bottle stores	0.179	0.157	-0.012	0.923	0.391	0.001	0.009	0.947	0.256	0.044
Supermarkets/ general stores/dairies	0.120	0.632	-0.120	0.617	0.129	0.577	-0.106	0.687	0.085	0.734

*Significant p<0.05

The two steps taken thus far suggested that crime occurring at different places had a relationship with both control and outlet density variables despite obvious collinearity. The third step, therefore, was to examine the relationship between the density of alcohol outlets and violent crime after controlling for confounders. As in the previous analysis of hospitalisation, all control variables were entered as a block.

8.4.3 Net effects of density on crime

Most of these results reached significance but some which did not reach significance will also be presented. For example, if on-licensed premises were significant in minor crime but not in serious crime, then the results will be shown for both, but where either minor or serious crimes were not significant (e.g. when examining crime occurring at road sides), such results are not presented**.**

The regression analysis indicated some significant results for the density of some alcohol outlets in predicting total crime, crime occurring at dwellings, licensed premises and roads/public places. The first model was estimated for total alcohol outlets and crime occurring in different places. This analysis was then repeated for both on- and off-licensed premises, and when necessary, two categories of off-licences (supermarkets and bottle stores).

8.4.3.1 Influence of total alcohol outlets on crime

Table 8.13 indicates that the density of all alcohol outlets helps to explain serious crime occurring at dwellings and licensed premises. Total alcohol outlets were significant after adding control variables. Most of the variance in serious violent crime occurring in dwellings and licensed premises was explained by the density of total alcohol outlets. For crime occurring at dwellings, despite predicting only 4.2% of the variance, the influence of the density of total alcohol outlets was slightly higher than all control variables. The control variables, however, were not significant.

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Table 8.13: Regression results for crime occurring in dwellings and licensed premises and the density of total alcohol outlets, controlling for confounding variables

Variables	Standardized Coefficients	p value	R^2	Net R^2 due to density variable	Standardized Coefficients	p value	R^2	Net R^2 due to density variable
	Serious violent crime				**Minor violent crime**			
				Crime occurring at dwellings				
(Constant)		0.000				0.019		
% 15-24	-0.197	0.139			-0.059	0.558		
% Māori pop	0.004	0.983			0.345	0.009		
NZ deprivation	0.272	0.124	0.037		0.375	0.006	0.452	
Total alcohol outlets	**-0.259**	**0.046**	**0.079**	**0.042**	**-0.179**	**0.068**	**0.471**	**0.019**
				Crime occurring at licensed premises				
(Constant)		0.785				0.576		
% 15-24	0.101	0.422			0.146	0.232		
% Māori pop	0.486	0.004			0.408	0.011		
NZ deprivation	-0.311	0.066	0.096		-0.215	0.185	0.065	
Total alcohol outlets	**0.381**	**0.003**	**0.212**	**0.116**	**0.499**	**0.000**	**0.264**	**0.199**

Dependent Variable: crime

Bold shows main study factor (density of alcohol outlets)

The density of total alcohol outlets predicted more than half the total variance explained in serious crime occurring at licensed premises with total net variance due to density at 11.6% for a cumulative total explained variance at 21.2%. For serious crime occurring at dwellings the regression coefficients were negative, but for licensed premises they were positive. In other words, places with more serious violent crime occurring at dwellings were associated with a lower density of alcohol outlets compared to crime at licensed premises which was associated with a higher density of alcohol outlets and a higher percentage of Māori living in the area.

Alcohol outlet density was the most important predictor of minor crime occurring at licensed premises, predicting most of the total variance explained. The variance for minor crime occurring at licensed premises predicted by all alcohol outlets was 19.9% for a cumulative R^2 of 0.264, indicating that alcohol outlets predict most of the explained variance. Similar to serious violent crime, the proportion of Māori was also significant. Places with a higher density of alcohol outlets and higher percentages of Māori were at increased odds of licensed premises being associated with minor violent crime. This result for licensed premises was not surprising, since this was crime that occurs where alcohol was sold and consumed and most of the alcohol outlets were on-licences and were located in deprived areas mostly inhabited by Māori (See Chapter 6). The next step was to determine if the explanations of crime varied.

8.4.3.2 The influence of outlet types on crime: on- and off-licences

As with hospitalisation the type of alcohol outlets is important in crime research and was examined. It has been suggested that different outlets impact on different crimes. Off-licenses are associated with domestic violence since alcohol is bought and consumed at home (Roman et al., 2008). On-licenses were associated with serious assault, injury and petty theft (Gruenewald and Remer, 2006, Roman et al., 2008, Roncek and Maier, 1991). Recent research in Manukau, a city in Auckland, New Zealand, has indicated that higher density of on- and off-licensed premises have a strong and positive relationship with crime (Cameron et al., 2010). It was therefore important to separate the different outlets and to examine which contributed most to the various types of crime and whether or not this association applies through out in New Zealand.

Table 8.14: Regression results for dwelling crime rates and density of on-licences and off licenses, controlling for confounding variables

Variables	Standardized Coefficients	p value	R^2	Net R^2 due to density variable	Standardized Coefficients	p-value	R^2	Net R^2 due to density variable
	Serious violent crime occurring at dwellings				**Minor violent crime occurring at dwellings**			
On-license								
(Constant)		0.000				0.031		
% 15-24	-0.172	0.180			-0.033	0.733		
% Māori pop	-0.002	0.989			0.344	0.010		
NZ deprivation	0.264	0.135	0.037		0.370	0.007	0.452	
On-licenses	**-0.251**	**0.047**	**0.079**	**0.042**	**-0.149**	**0.119**	**0.463**	**0.019**
Off-license								
(Constant)		0.000				0.014		
% 15-24	-0.205	0.135			-0.077	0.453		
% Māori pop	0.014	0.934			0.350	0.008		
NZ deprivation	0.279	0.117	0.037		0.382	0.005	0.452	
Off-licenses	**-0.247**	**0.063**	**0.072**	**0.035**	**-0.196**	**0.050**	**0.481**	**0.029**

Dependent Variable: Crime

Bold shows main study factor (density of alcohol outlets)

Table 8.14 illustrates the influence of density of on- and off-licensed premises on both minor and serious violent crime occurring at dwellings. While the density of on-licences had no relationship with minor violent crime occurring at dwellings, density of on-licences was a good predictor of serious violent crime occurring at dwellings. The density of on-licences was significant after adding all the control variables and explains

4.2% of the variance in serious violent crime occurring at dwellings. Significantly, on-licences predicted most of the variance in serious violent crime occurring at dwellings. The variance explained thus was higher than the variance predicted by all the control variables, even though none of the control variables was significant.

There was no association between density of off-licences and serious violent crime occurring in dwellings. There is, however, an association between the density of off-licences and minor violent crime occurring at dwellings. The variance explained was 2.9% of crime occurring in dwellings for a cumulative R^2 of 0.481. The highest explanation of the variance of minor violent crime occurring at dwellings was attributed to control variables. Minor crime occurring at dwellings was therefore most characteristic of deprivation and ethnicity. Since the regression coefficients are negative, the results suggest that as minor crime occurring at dwellings increases, the density of off-licences reduces. Places where the serious violent crime at dwellings was high had a lower density of on-licences, although this relationship was not significant.

Table 8.15 illustrates the regression analyses for the types of alcohol outlets and both serious and minor crime occurring in licensed premises. After adding all control variables, both on and off-licences were significant ($p < 0.05$) for both minor and serious violent crime occurring in licensed premises and predicted the biggest proportion of the explained variance in minor crime occurring there. For instance, for serious violent crime occurring at licensed premises, the variance explained by the density of on-licensed premises was 12.5%, which was more than half of total variance explained, for a cumulative total of 17.5% of total explained variance. Similarly, for the density of off-licences the variance explained was 8.2% for a cumulative total explained variance of 13.8%, showing that density of off-licenses predicted more than half of the explained variance in serious violent crime occurring at dwellings.

With minor crime occurring at dwellings, the variance predicted by density of on-licenses was 21.6%, and control variables only predicted 2.3% for total explained variance of 23.9%. This showed that almost all the explained variance of minor crime occurring at licensed premises was predicted by on-licences. Additionally, off-licences predicted almost the entire total explained variance of minor crime occurring at licensed premises. For both minor and serious violent crime occurring at licensed premises, the percentage of Māori within TAs is significant suggesting that areas with a higher density of on-and off-licences and a significant population of Māori have higher odds of violence associated with licensed premises

Table 8.15 Regression results for licensed premises crime rates and the density of on- and off-licensed premises, controlling for confounding variables

Variables	Standardized Coefficients	p value	R^2	Net R^2 due to density variable	Standardized Coefficients	p value	R^2	Net R^2 due to density variable
	Serious violent crime occurring at licensed premises				**Minor violent crime occurring at licensed premises**			
On-licence								
(Constant)		0.940				0.752		
% 15-24	0.070	0.560			0.106	0.360		
% Māori pop	0.497	0.003			0.424	0.008		
NZ deprivation	-0.299	0.075	0.050		-0.199	0.214	0.023	
On-licences	**0.385**	**0.002**	**0.175**	**0.125**	**0.507**	**0.000**	**0.239**	**0.216**
Off-licence								
(Constant)		0.875				0.706		
% 15-24	0.104	0.428			0.149	0.249		
% Māori pop	0.469	0.006			0.386	0.019		
NZ deprivation	-0.319	0.063	0.056		-0.226	0.177	0.023	
Off-licences	**0.344**	**0.008**	**0.138**	**0.082**	**0.449**	**0.001**	**0.173**	**0.150**

Dependent Variable: Crime

Bold shows main study factor (density of alcohol outlets)

8.4.3.3 Influence of the off-licence categories on crime

Additional analysis was performed for the off-licence categories of supermarket/ general stores/dairies and bottle stores. These two categories were important because they are suggested to be associated with increased crime rates (Roman et al., 2008). Bottle stores sell hard liquor (spirits) in addition to beer and wine which intoxicates people quickly. Alcohol bought from off-license is unregulated and people can buy as much alcohol as they want (Boyle et al., 2009, Galloway et al., 2007) and sometimes this drinking takes place around the places where alcohol was purchased. Similarly, there is no regulation on the amount that can be bought from a supermarket or a general store/dairy. Further analysis is therefore undertaken for two off-licenses categories. The results presented are for minor crime occurring on licensed premises, on roads and in public areas since they were the only significant results.

For minor violent crime occurring along roads the analysis indicated that the only significant off-license outlets was the bottle stores (Table 8.16). These predicted 4.7% of the explained variance in minor violent crime along the roads after all the control variables were added. For every unit increase in bottle store numbers, crime rates per 10 000 increased by 1.02. The most important explanatory variables were the area deprivation and percentage of young people 15-24. Areas of high deprivation, many young people aged 15-24 and a higher density of bottle stores increases the odds of engaging in minor violent crime by the road side. No other alcohol outlet was significant.

The density of supermarkets and general stores/dairies predicted crime occurring at licensed premises. Supermarkets and general stores/dairies predicted a larger explained variance in minor crime occurring at licensed premises than all the confounding variables, which were not significant (5.2% versus 2.3%). This relationship is interesting because it suggests that areas with a higher density of supermarkets and general stores/dairies were associated with higher rates of minor crime at licensed premises, possibly a result of pre-loading(consuming cheap alcohol from off-licences before going to an on-licensed premises) (Withrington, 2007).

Table 8.16: Regression results for minor violent crime rates on roads, in public places and at licensed premises and categories of off-licences, after controlling for confounding variables

Public Places	Standardized Coefficients	p-value	R^2	Net R^2 due to density variable
(Constant)		0.509		
% 15-24	0.225	0.050		
% Māori pop	-0.105	0.512		
NZ deprivation	0.376	0.025	0.145	
Bottle Stores	**0.219**	**0.046**	**0.183**	**0.047**
Licensed premises				
(Constant)		0.550		
% 15-24	0.042	0.742		
% Māori pop	0.332	0.053		
NZ deprivation	-0.161	0.359	0.023	
Supermarkets/general stores/dairies	**0.295**	**0.021**	**0.085**	**0.052**

Dependent Variable: Crime

Bold shows main study factor (density of alcohol outlets)

8.5 Summary of results

This study indicates that 'place' characteristics, more specifically alcohol outlets predict minor and serious violent crime. While some studies have relied on predicting total crime (Gorman et al., 1998a, Gorman et al., 1998b), this chapter was able to explain the variations for all violent crime combined and stratified by the place where violent crime occurred. Of most importance was isolating outlets that contributed most to the different types of crime, an action that has been previously ignored in New Zealand.

Regression analysis indicated that the relationship between the density of alcohol outlets, by type and category, varied in predicting crime. The different outlets predicted crime after the analysis models controlled for confounders. For most of the significant models, the highest variance was explained by the density of alcohol outlets. All control variables were entered as a block, and when the alcohol outlet variable was entered, there was a significant change in R^2 and alcohol outlets remained significant.

The study examined the relationship between different places where crime occurred and the density of all alcohol outlets. The results showed that total serious violent crime was not predicted by total alcohol outlets, however when the crime was separated by places where the crime occurred, total alcohol outlets explained the highest variance in serious violent crime occurring at dwellings and at licensed premises when compared to control variables. Similarly, for minor crime occurring at licensed premises the highest variance (almost 70% of the total explained variance) was predicted by the density of total alcohol outlets.

When the outlets were stratified by type, there were varied predictions; however, in most cases the density of alcohol outlets was the most important explanatory variable. Off-licences predicted more than half the total *explained* variance of serious crime occurring in licensed premises. Additionally off-licences predicted most of the total *explained* variance for minor crime occurring at licensed premises. Off-licences predicted 2.9% variance of crime occurring at dwellings and confounder variables predicted 45%, showing that confounder variables predicted most of the *explained* variance, while there was no association between off-licences and serious violent crime, including homicides.

The density of on-licences predicted more than half the total *explained* variance of serious violent crime occurring at dwellings although the regression co-efficient was negative showing that as dwelling crime increase, number of on-licenses reduced. The density of on-licences predicted most (70%) of total *explained* variance of serious crime occurring at licensed premises. Similarly, and not surprising, on-licences predicted almost all (87%) of the total explained variance for minor crime occurring at licensed premises.

While only 8% variance was *explained* for crimes occurring at licensed premises, at 5% the density of supermarkets had the strongest explanatory power (70%). Areas with higher density of supermarkets/ general stores/dairies therefore, are associated with licensed premises crime. For bottle stores model, the highest variance in crime occurring on roads or public places was explained by control variables.

The results presented in this chapter suggest that after controlling for confounding variables, alcohol outlets stratified by type are a good predictor of both serious and minor violent crimes. Even though the total *explained* variance was low, nonetheless alcohol outlets predicted a significant portion. The main theme identified is that crimes occurring in different places are influenced by different types of outlets.

8.6 Conclusion

There are contextual effects of locating alcohol outlets in different neighbourhoods in relation to violent crime and hospitalisation. This study shows that the greater density of alcohol outlets was associated with an increase in violent crime, and more particularly, in the relatively deprived areas. Similarly, after controlling for confounding factors, density of alcohol outlets was associated with an increase in hospitalisation. Reasons for the observed significant results will be highlighted in Chapter 9.

This is one of the first few studies in New Zealand to examine the relationship between hospitalisation, crime and alcohol outlets stratified by type and category at a national level. While these results are interesting, they should be treated with caution because they do not indicate causality; rather they indicate the conditions that might lead to an increase in hospitalisation and/or crime. It is the presence of outlets and the amount of alcohol consumed that predisposes people in the surrounding areas to being either perpetrators or victims of crime (Roman et al., 2008). Similarly, it is the amount of alcohol consumed that leads to hospitalisation. Caution should be exercised regarding these results as some of crime analysed here was not necessarily related to alcohol consumption.

Chapter 9 Discussion

9.1 Introduction

Alcohol has been consumed since time immemorial in different parts of the world. For some sections of society the reasons for consumption have changed (WHO 2004). Historically what was once considered a social drink or a drink for special occasions has now become an end in itself leading to hazardous consumption (WHO 2004). Many reasons have been suggested for the increase in consumption and explanations have been varied. Initial studies on health focussed more on individual behaviours, however, from the 1990s there has been more interest in external environmental influences. There has been a dearth of studies that have examined ‘place’ effects that contribute to alcohol consumption and its subsequent outcomes, both worldwide and in New Zealand. This limits our understanding of the impact of external factors. This study is the first in New Zealand to examine the effect of ‘place’ on alcohol-related behaviour and its related impacts at a national level.

A range of quantitative methods were used to examine the aim and objectives of the thesis as evidenced in Chapters 5-8, and four key themes emerged. First, there has been an overall increase in alcohol-related mortality and hospitalisation over time and that both trends have been influenced by differences in age, gender, gender, ethnicity, urban/rural location and area deprivation. Secondly, this study successfully developed measures of access to alcohol outlets and found that disproportionately higher numbers of outlets are located in the most deprived areas. Consequently, residents living in such places not only live closer to alcohol outlets but also have a wider choice of outlets in close proximity highlighting inequity in the availability of alcohol outlets. Thirdly, the measures developed regarding the density of alcohol outlets and access to them, explain alcohol-related behaviour in some sub-populations but not others. Fourthly, the density of alcohol outlets had an association with alcohol-related impacts of crime and hospitalisation. Each of these key themes will be discussed separately below.

9.2 Increases in hospitalisation and mortality over time and the influence of individual and contextual factors

The public health model discussed in Chapters 2 and 3 emphasised that hospitalisation and mortality are mostly a function of excess alcohol consumption by individuals, but are also facilitated by some ‘place’ characteristics. Five key themes emerged from the analysis and results of hospitalisation and mortality in Chapter 5.

- Younger age groups are more likely to be hospitalised for alcohol-related reasons while the older age groups are the most likely to die from alcohol-related diseases. Additionally, while hospitalisations of the younger age groups have increased over time, mortality rates among the older age groups have declined over time.
- Hospitalisation and mortality rates are higher in men than women. However, for hospitalisation the female rates are increasing faster than those for males.
- Māori rates are higher for both mortality and hospitalisation than non-Māori.
- While the urban rates were higher for both hospitalisation and mortality, the rural rates for mortality were the fastest growing.
- People living in the most deprived areas were more likely to be hospitalised or die than those in the least deprived areas. In addition, the hospitalisation and mortality rates had increased in the most deprived areas but decreased in the least deprived areas.

Each of these themes will be discussed independently.

9.2.1 Hospitalisation and mortality differentiated by age

This study has indicated that young people aged 15–24 were more likely to be admitted to hospital for alcohol-related illnesses while there were few admissions in the older age group of 65 and over. Regression analysis showed that within the first period (1999-2002), those aged 15–24 years had 1.05 times higher hospitalisation rates than the reference group (those aged 65 and over) and this increased to 1.53 within the second period (2003-2006), showing that the rates within this (15-24) age group had risen by 46% compared to the reference group. This increase is consistent with studies worldwide (WHO 2004), and more specifically in England (Jones et al., 2008) and the

Netherlands (Valkenberg et al., 2007) which also showed increases in hospital admissions for the younger ages. However, these results were different from the age-standardised rates in Scotland which were higher in those aged 35-44 (NHS, 2010). This discrepancy can be related to use of different ICD codes, and probably because the New Zealand rates were age-standardised using the New Zealand population rather than WHO population proportions. Mortality rates in New Zealand were higher for those aged 65 years and over, which is consistent with research in both New Zealand (ALAC, 2008) and Australia that used similar codes (Australian Bureau of Statistics, 2006).

Alcohol-related hospitalisation and mortality are associated with heavy alcohol consumption. While younger age groups aged 15-24 were more likely to be admitted for minor diseases, the older age groups aged 65 years and over were more likely to die from serious diseases such as cirrhosis of the liver. Increasingly, heavy alcohol consumption is associated with younger age groups 15-24 and surveys undertaken in various countries including New Zealand (New Zealand Health Survey, 2006/07), Australia (AIHW, 2005), Canada (Health Canada, 2005), Great Britain (Plant and Plant, 2006), Nordic Countries with the exception of Denmark (Mäkelä et al., 2001) reported increasing consumption amongst the younger age groups (15-24). In New Zealand, for instance, there are frequent media reports discussing the youth culture of hazardous consumption (Thomas, 2009). Younger age groups are more likely to be hospitalised suffering from the toxic effects of alcohol and from alcohol use disorder (Christie, 2008, Jones et al., 2008). Both older males and females (65 and over) were more likely to die from alcohol-related causes. This result should be treated with caution because of high confidence intervals in mortality. This pattern is consistent with international literature which shows that this age group is more likely to die from alcohol-related conditions such as cirrhosis of the liver or pancreatitis that are a result of heavy drinking (Sand et al., 2009), and which take a long time to develop (Breakwell et al., 2007). Results from this study show that the crude rate for cirrhosis of the liver is higher in this age group than all the other age groups combined (Leon and McCambridge, 2006). These observations relate to data only for diseases caused by alcohol consumption and exclude road accidents which normally account for a large portion of the alcohol-related mortality in the younger age groups.

While there are many reasons for heavy consumption amongst both the older and youngest age groups as discussed in Chapters 2 and 3, there are other important influences such as gender, ethnicity, and area level socio-economic status. For example, young people who live in deprived areas in Auckland, with access to alcohol outlets within 10 minutes were more likely to consume alcohol hazardously (Huckle et al., 2008). Similarly, this study also found that younger people 15-24, especially Māori and Pacific Island people and people aged 75 and over, were also more likely to consume hazardously if they were living closer to an alcohol outlet. These results show that there are also some ‘place’ effects that influence consumption amongst the younger and older age group. It is worth noting that age-standardised rates were calculated at CAU level while distance measures were calculated at meshblock level. Sometimes what happens at a small geographical level may produce insignificant results when the geographical size is increased or vice versa (Exeter and Boyle, 2007, Flowerdew et al., 2008, Openshaw 1984).

9.2.2 Higher rates amongst males but increasing rates in females

Worldwide patterns show that most alcohol-related hospitalisations and mortality are dominated by males (Hanlin et al., 2000). This study also found that for the entire period (1999–2006) more males were hospitalised than females. However, the gender gap has reduced significantly over the years from a high of 150 in 1999 to 130 per 100 000 in 2006. Considering the time lag before alcohol consumption causes illness, this decreasing gap is significant. Female rates have increased especially among the 15-24 age group. This is consistent with results from UK (Jones et al., 2008, O'Farrell et al., 2007). Earlier results showed that males aged 55 years and over, had rates of hospitalisation three of four times higher than females while the ratios at the younger age groups were on average two times higher. Even more interesting, is that the ratios have declined over the years. Since hospitalisation is used here as a proxy, the assumption is made that this result is consistent with the literature, which shows that women in the younger age groups aged 15-24 are now consuming more alcohol than previously (Babor et al., 2003, WHO, 2002). Two assumptions can be made; either men’s consumption may be reducing or women’s hazardous consumption is increasing. In New Zealand, however, the latter is true with analysis of the trends showing a marginal increase for males and significant increases for women. For those aged 15–24 the increase in females was higher than for males (84% versus 42%). The regression analysis also showed that despite a twofold difference between males and females the gender gap has narrowed. The mortality gender gap also narrowed but the case in New Zealand differs from UK, where mortality rates for males have doubled within 20 years (9.1–18.7 per 100 000) compared to those for women which increased from 5.0–8.7, from 1981-2001. The gap between males and females widened in UK (Breakwell et al., 2007), but New Zealand experienced a slight decline between male and female mortality rates over time (1994-2005).

While the reasons for male consumption have been researched and were thought to be related to traditional roles and ‘masculinity’ (Deemers et al., 2002, Mahalik et al., 2007), female consumption is on the rise and many reasons have been given for this trend. This trend is attributed to labour market changes which have enabled women to take up more senior positions than formerly and resulted in a change in social roles with more women tending to consume alcohol excessively (Emslie et al., 2002, Burger and Mensink, 2004). Women who are in managerial positions are more likely to be heavy consumers than their male counterparts in a similar position (Emslie et al., 2002, Burger and Mensink, 2004). Similarly, in the US women with higher education were most likely to have senior positions and therefore consume more alcohol (Celentano and McQueen, 1984). For younger women, their drinking patterns have been attributed to new alcoholic drinks such as alcopops and light beer which are manufactured for and targeted to the non-traditional consumers, such as women (WHO 2004). In addition, advertising which targets females has also played a role in the increase in female consumption (McCreanor et al., 2008).

9.2.3 Higher rates amongst Māori compared to non-Māori

This study found that Māori hospitalisation rates were double those of non-Māori, while for mortality, Māori rates were triple those of non-Māori. Similar results were reported by ALAC (2008) who also found that Māori mortality rates were two and three times higher than non-Māori in hospitalisation and mortality respectively. Sachdeva (2010) and Craig and Jackson (2006) also reported two times higher rates for Māori in Canterbury and Counties Manukau respectively. The smaller ethnic gap in hospitalisation between Māori and Non-Māori was because while the Māori female rates are twice as high as non-Māori female, the difference between Māori and non-

Māori male rates were slightly less than two. This narrow gap is also reflected in Māori age patterns which show that those most likely to be hospitalised are males 15–34 and females aged 15-44, showing a wider age range for Māori females. For older Māori, there has been a reduction in hospitalisation over the years and especially for Māori males aged 55–64, where the rates have reduced significantly. Studies in America (Dawson et al., 1995, Makimoto, 1998) and in the UK (Stillwell et al., 2004) have reported that minority ethnic groups are known to be heavy alcohol consumers and also to suffer worse alcohol-related consequences since they tend to be of low socio-economic status. Similar results were observed in New Zealand where the NZHS (2006/7) shows that, while non-Māori consume alcohol more frequently, Māori persons are more likely to be hazardous consumers. Kypri (2003) argues that the reason why overall Māori hospitalisation rates are higher is because a disproportionate burden is borne by young people. The Māori population under 35 years accounts for 69% of the total Māori population compared to non-Māori at 47%. The NZHS (2006/7) also found that the highest consumption was amongst the younger 15-24 Maori. Since these younger people are the majority in the Maori population, the burden is therefore higher when compared to other groups.

For mortality, Māori rates were three times higher than for non-Māori, and the confidence intervals did not overlap despite being high. While similar rates were reported in an earlier New Zealand study that also examined other ICD codes, it was found that while non-Māori benefitted from extra years because of moderate consumption, Māori did not (Connor et al., 2005). Connor et al., (2005) further argue that maybe there are other confounding factors, possibly because of binge drinking, but it can be argued that the differences lie in 'place' features. This study found that Māori and Pacific Island persons have higher odds of alcohol consumption when living closer to alcohol outlets, or when having better access to a range of outlets within walking or driving distance, illustrating the importance of geography.

9.2.4 Higher rates in urban areas but increasing mortality rates in rural areas

In this study, the hospitalisation and mortality rates were stratified by gender. Urban male rates were almost two times higher than their rural counterparts, with slightly lower gaps for urban and rural females. For both genders, there was an increase in urban rates toward 2006, but a decline in rural rates, indicating an increasing gap. This result is consistent with the literature in Australia (Hanlin et al., 2000) which indicated that there has been a general decline in hospitalisation rates for both males and females in rural areas. In Sweden, urban rates were also higher after controlling for a range of confounders (Kristina and Gölin, 2004). While hospitalisation rates have been higher in urban than rural areas, there is no consensus from other studies on whether urban or rural areas have the highest rates of hospitalisation. Research has presented evidence for both scenarios with higher rates in urban areas (Hanlin et al., 2000, Kristina and Gölin, 2004) while others have indicated higher rates in rural areas (Stickley and Razvodovsky, 2009). However, for mortality, for both genders, urban rates are slightly higher although for males, in the later years, the rural rates were higher than urban. This result is not consistent with studies undertaken in England and Wales, urban men had higher mortality rates even after controlling for area SES between 1999 and 2003 (Erskine et al., 2010).

There is evidence that for both males and females in New Zealand's rural areas, hospitalisation rates have declined substantially, but whether this is attributed to a decrease in consumption is a matter of conjecture. One suggestion is that alcohol is easily accessible in urban areas but not in rural areas. Nonetheless, the decline cannot be related to access because there is no evidence to show that alcohol outlets have decreased in number in rural areas. In addition, not all people's consumption was influenced by proximity, but only some segments of the population.

Male mortality rates in rural areas have increased significantly and in more recent years were even higher than urban rates, however, caution should be taken in interpreting the result because of high confidence intervals in mortality. This increase is a surprising result and more studies are needed to determine the reason for this. However, research in Australia and USA also found that high risk drinking and its associated harm was concentrated in the most remote rural areas (AIHW, 2005, Jackson et al., 2006). One possible explanation lies in the age structure of rural areas which tends be weighted towards older people who have been drinking for a considerable amount of time over their lifetimes. The other possibility advocated by Smith et al., (1982) is that most of the young men who are hazardous consumers have migrated to the cities, leaving behind older men and women whose rates of alcohol-related mortality are significantly higher. People in rural areas are probably diagnosed with advanced alcohol-related diseases.

Since access to medical care is poor, they wait until it is too late. An assumption is made that this observation could be because of increased distance to health services in rural areas (Aday and Andersen, 1974). It is suggested that people in rural areas might not visit the hospital frequently or early enough because of the distance (Aday and Andersen, 1974, Bentham and Haynes, 1985, Haynes et al., 1999, Lovett et al., 2002), especially for alcohol-related illness (Fortney and Booth, 2001).

Spatial analysis relating consumption to alcohol outlets for both urban and rural areas presented interesting findings. There was no association between the distance to, or the density of, alcohol outlets and alcohol-related behaviour in urban areas; however, rural females and males exhibit strong 'geography' illustrating that distance and density are important factors. This observation is interesting because most studies tend to concentrate on urban areas as the trouble spots. It is suggested that people in rural areas have more social capital and cohesion (Ziersch et al., 2009) and therefore they can discourage members of the community from hazardous consumption. However, Stead et al., (2001) suggest that sometimes strong social capital actually increases consumption, since people have similar behavioural characteristics and strong neighbourhood identity.

9.2.5 Higher rates amongst the most deprived compared to the least deprived

This study found that hospitalisation and mortality rates in the most deprived areas are double those of the least deprived and increased over time. The differences and increasing rates over 8 years period- shows that there was increased inequality between the most and least deprived areas. Similar results were reported by ALAC (2008) and also in Counties Manukau and Waikato (Craig and Jackson, 2006, Waikato District Health Board, 2005). The results were also similar in Scotland, the only difference being that between 2004 and 2005 the most deprived areas had seven times higher rates than the least deprived (NHS, 2010). Many studies have highlighted the increase in health inequalities in New Zealand and were able to report that the differences in deprivation quintiles have worsened over the years (Pearce et al., 2007). The difference in deprivation quintile can be related to higher rates in the most deprived quintiles for men than women. While there was a fivefold difference in hospitalisation between the least and most deprived men, the most deprived women had double the rates of the least deprived. Similar results were observed in England and Wales between 1999 and 2003 with higher rates in the most deprived areas (Erskine et al., 2010).

Low SES has been associated with social issues such as isolation and stress, which can lead some people to seek solace in alcohol (Jennison, 1992, Volpicelli, 1987, Sadava and Pak, 1993). Pearce et al., (2008a) argue that the reason for the increased alcohol uptake in low income areas may be because more alcohol outlets are concentrated there. Moreover, most alcohol advertisements also focus on such areas. This argument shows that not only are the poor vulnerable because they are already poor, but alcohol services are within easy reach and advertisements entice people of lower income to consume more by offering cheap alcohol. In New Zealand, the 2006 census data showed that Māori people are more likely to live in low income areas, and therefore more are vulnerable to neighbourhood factors such as poor housing and suffer most of the worst consequences including ill health (Robson et al., 2007). Such results in deprived areas showed that there are neighbourhood factors, such as access to alcohol outlets that are important in understanding why the rates in the most deprived areas are growing faster than in the least deprived areas. These results show that both compositional and contextual factors are important in explaining alcohol-related hospitalisation and mortality. Other writers suggest that the relationship between SES status and alcohol consumption is complex and ranges from the broader global and national economies to impacts upon local employment (Curtis, 2004).

9.3 Access to and availability of alcohol outlets

The analysis for all of New Zealand shows that there is inequitable distribution of alcohol outlets. There is a social gradient with the number of alcohol outlets increasing as area deprivation increases whether measured by the rate of alcohol outlets per 10 000 people or by median distance. Most deprived neighbourhoods have disproportionately higher densities of alcohol outlets and consequently shorter distances to reach them and a wider choice of outlets. For instance, at the national level, the median distance to all alcohol outlets in the most deprived areas is 727 metres, compared to 1.5 kilometres for the least deprived. These results are consistent with other studies in New Zealand (Pearce et al., 2008a, Hay et al., 2009, Huckle et al., 2008) and also internationally (Pollack et al., 2005, LaVeist and Wallace, 2000). However, in Glasgow, the location of alcohol outlets was more mixed and not heavily concentrated in deprived areas (Ellaway et al., 2010). Apart from straight distance measures, few studies, however, have examined buffers of 800 and 3000 metres in alcohol research. However, researchers have reported higher densities of resources such as fast food outlets, parks and recreational facilities within such buffers (Bjork et al., 2008, Crawford et al., 2008, Pearce et al., 2008a, Smiley et al., 2010, Spence et al., 2009). This study found that higher densities of alcohol outlets within buffers of 800 and 3000 metres are in the most deprived areas. Despite the fact that there are fewer alcohol outlets in rural areas, there is still a social gradient in such areas, consistent with other research conducted in New Zealand (Hay et al., 2009). Social gradients are also characteristic of the 16 administrative regions and are related to the historical establishments of outlets in certain regions.

It is important to try and understand why more outlets are more concentrated in less affluent areas. One suggested reason is the lack of social capital (Weitzman et al., 2003b) to stop their proliferation. Theall et al., (2009) also found that a higher density of alcohol outlets in neighbourhoods was associated with reduced social capital measured by active organisational membership (church/religious group, community or neighbourhood organisation and voting) and collective efficacy (measured by a range of questions on social cohesion and informal social controls). Pearce et al., (2008a) also cite lack of civil resistance, however recently there have been a resistance to opening of new outlets in Manukau City after residents complained that there were too many outlets and an accompanying increase in anti-social behaviour (Mangnall, 2010). Interestingly enough, the area is a comparatively poor area yet such resistance is normally associated with richer suburbs. Other writers found that advertisements are targeted towards poorer neighbourhoods (Alaniz, 1998) thus encouraging low income neighbourhoods to consume alcohol, thus exacerbating the problem.

There is a need to look at the broader structural issues within local governments (Curtis, 2004). For instance, liberation of the economy is more about businesses making money, so potential owners choose their locations carefully, often seeking areas with low rental and land prices (Speer et al., 1998). The Resource Management Act 1991, which provides guidance on the location of businesses is not very specific and is suggested to be responsible for zoning and may be one reason for the inequitable distribution of alcohol outlets (Hill, 2004). Pearce et al., (2008a) concurs with Hill (2004) in seeking an understanding of the reasons behind the location of alcohol outlets. There is a need to understand land values and the history of planning and zoning measures in New

Zealand, given that the cost of land and rent is lower in deprived areas (Pearce et al., 2008a). Resources in New Zealand, including parks, fast food outlets and supermarkets are often found in deprived areas, because most designated commercial zones are located there (Pearce et al., 2008a). Speer et al., (1998) suggests that since many outlets are located in deprived areas, 'legitimate' business owners will not locate in such areas because of fear of crime and the established businesses might also relocate thus encouraging more alcohol outlets in one area. There are other policy issues related to the location of alcohol outlets, especially with the Sale of Liquor Act (1989) (Hill, 2004). Wine sales were legally allowed in supermarkets in 1989 and beer sales in 1999 and these policy changes are suggested to have made alcohol available in outlets where they previously were not available (Hill, 2004). From 1987, there were about 6 000 licensed outlets including restaurants, and the number has increased to about 14 800 currently, mostly because of an increase in number of supermarkets, convenience stores and restaurants that now sell alcohol (Kypri et al., 2005c). However, as explained in Chapter 4, this study focussed only on main alcohol outlets licensed up to 2005, but not restaurants.

Regional differences are suggested to be because of historically inculcated drinking cultures and establishments of alcohol outlets. Areas such as the West Coast which traditionally were mining towns had more alcohol outlets that have now been turned into tourist drinking areas. Alcohol breweries and retail outlets were therefore established in such regions with more outlets because of three reasons namely: occupations of the local populace; following the railway line; and because of prohibition therefore establishments of working men's clubs (Hutchins, 2009). The patterns that currently exist in the regions derive from one or more of the aforementioned factors. It is suggested that whalers, sealers, seafarers, builders, gold miners lived in single camps but ventured into nearby settlements to 'quench their thirst' after hard labour. In Westland, for instance, during the 1860's gold rush, the three towns of Hokitika, Greymouth and Westport had a population of 28 700 (Te Ara 2009). This huge population resulted in an increase in alcohol retail outlets. In 1947, Greymouth alone had 21 bars for a population of about 9,000 and the people living there were famous for a boycott of alcohol when outlets increased beverage price. Eventually the outlet owners succumbed and reverted to the old prices (New Zealand Online History, 2010). Apart from West Coast, other mining towns such as Mangapehi and Barryville in south

Waikato, also had alcohol outlets established (Hutchins, 2009). Eventually places including the West Coast may attract tourists because of the high consumption of alcohol, a trait evident in Arachova, a small town in Greece, where alcohol outlets meant for tourists also offer locals many opportunities for consumption (Moore, 1995).

The King Country, in the North Island, was traditionally Māori country and most of the outlets in this region followed the railway line. The railway construction workers, bush fellers and land clearers created a demand for alcohol, hence the establishment of more retail outlets in such areas. It was also in such areas that working men's clubs were first formed, to cater for working men who wanted to drink in private clubs because of prohibition (Cullen, 1984). However, men's club are outlets and these contribute to an explanation of some of the differences by regions. Other places that established working men's clubs included Otago, Southland and Mt Roskill, among others. These early establishments illuminate the current alcohol outlet rates, where deprived areas have higher densities of alcohol outlets compared to other areas. Such historical trends partly explain the disproportionate distribution observed especially as illustrated in Chapter 6. The historical trends however, do not explain the reason for the disproportionate distribution of alcohol outlets in the most deprived areas. In Scotland, historical reports show that alcohol outlets were deliberately not located near areas where public housing are concentrated or in affluent areas (Ellaway et al., 2010), probably a similar reason why most outlets are in deprived neighbourhoods in New Zealand.

Bernard et al., (2007) and Macintyre et al., (2003) contend that it is important to understand the distribution of resources and how they explain health inequality. Alcohol outlets in New Zealand are disproportionately distributed with more outlets in poor than in rich areas. However, whether or how this distribution increases hazardous consumption is not well understood. The next section therefore discusses the results of the relationship between outlets and alcohol-related behaviour and its impacts, and suggests possible theoretical reasons for the association.

9.4 Access and density in relation to alcohol-related behaviour

9.4.1 Access to alcohol outlets and consumption

Alcohol consumption was measured in two ways; hazardous consumption and frequent consumption of five or more drinks. This was also true of proximity to alcohol outlets which was considered in terms of both access distance and the density of outlets. At the national level, for the general population, there is no association between hazardous and frequent consumption, and proximity to alcohol outlets. However, when analysis is undertaken for different sub-populations, there are significant associations. While the results indicated significant results sometimes at baseline, this was not the case after controlling for all confounding variables. For example, nationally, there are statistically significant results for the longest distance (> 2.2 kilometres) at baseline. However, after adjusting for potential confounding variables this association diminished and was statistically insignificant. Similarly, other alcohol-related behaviour had no association with distance at the national level. These results show that, for the population as a whole, living next to an outlet does not appear to influence alcohol-related behaviour, a result consistent with studies conducted elsewhere (Pollack et al., 2005, Galea et al., 2007), although these studies measured only excess consumption.

The analysis was further stratified by different sub-populations and significant results were noted amongst Māori and Pacific Island people. For this group of people, younger males aged 15–24 were more likely to have higher odds of hazardous consumption when living less than 571 metres from an alcohol outlet even after controlling for a range of potential confounding variables. As distance increased, hazardous consumption reduced, a pattern not seen in other ethnic groups of similar age. This result is consistent with studies that have examined homogenous groups such as university students (Weitzman et al., 2003a, Wechsler et al., 2002) and adolescents in Auckland (Huckle et al., 2008). For those aged 75 and above, there is strong distance decay, where those living closer to alcohol outlets are at higher odds of consuming alcohol frequently, even after controlling for a range of confounding variables, including personal income, individual deprivation, urban/rural and area deprivation. These results for younger and older people are consistent with the literature that the people most likely to encounter strong neighbourhood influences are both the young and the old who are often without cars, with reduced access to public transport, in poor health, and with low income

(Kobetz et al., 2003, McNeil et al., 2006, Robert and Li, 2001). American obesity studies also reported that minority and black populations were amongst those most likely to be influenced by resources in their neighbourhoods (Frank et al., 2007)

Significant results were also observed when 'place' features were measured by the density of alcohol outlets (using 800 metre and 3000 metre buffers). For buffers of 800 metres Māori and Pacific Island males and females have higher odds of frequent consumption when living in neighbourhoods with seven or more outlets, compared to those living in neighbourhoods with no outlets. Māori and Pacific Island females aged 25–34 are more likely to consume five drinks frequently if they live in areas with many outlets within a radius of three kilometres. Suffice to say that 65% of those who consume five or more drinks frequently were hazardous consumers since this is one measure that contributes towards the AUDIT score. While Māori and Pacific Island people are more likely to be influenced by 'place' features, given that they have the highest rates of adverse consumption, two results stand out for Europeans. First, after controlling for individual characteristics and contextual variables, young European females (15–24) living in neighbourhoods that have seven or more outlets within walking distance have increased odds of hazardous alcohol consumption. Secondly, male Europeans aged 55–64 have higher odds of frequent consumption with an increasing density of alcohol outlets within a three kilometre radius. Density measures also captured a wider choice of alcohol outlets than distance measures. These results were significant after controlling for both socio-demographics and area level factors and suggest that alcohol-related behaviour for these sub-populations is influenced by ''place''. Similar results were observed by Schonlau et al., (2008) who found that density of alcohol outlets within a one mile buffer was associated with alcohol consumption in Louisiana but not Los Angeles. Frank et al., (2009) also found significant differences in both gender and ethnicity and increased risk for obesity depending on different measures used such as physical activity, walkability and access to different food outlets.

There are some general reasons that have been suggested to link 'place' to hazardous consumption or unhealthy behaviour. Macintyre et al., (2003), contend that spatially patterned health inequality arises as a result of the unequal distribution of resources. This is evident in this study where the unequal distribution of alcohol outlets (concentrated in deprived areas) resulted in hazardous consumption (Bernard et al., 2007). There are both direct and indirect impacts of alcohol outlet density on individual behaviour. Scribner et al., (2000) argue that alcohol outlets have a structural influence on norms and consumption patterns within the community, which explains individual consumption. Scribner et al's., (2000) study reported that neighbourhoods with easy access to alcohol outlets have heavier drinking norms and therefore individuals' consumption patterns are influenced by such norms, especially in high density outlet zones. Skog et al., (1995) and Paton (2001) have supported the theory that social networks within the community influence one's drinking pattern. Ahern (2007) argues that drinking norms are important because if an individual wants to consume alcohol excessively and there are stronger norms against heavy consumption, they will not drink heavily, but if the norms allow, they will.

Bernard et al., (2007) argue that apart from social networks, cognisance must be taken of an individual's economic means and lifestyle preferences as well as mobility. Similarly, the Structuration Theory (Giddens, 1984) recognises that social structures influence individuals' behaviour strongly and at the same time individuals' behaviour reproduces and transforms structures (Gatrell, 2002). As stated earlier, those most likely to be affected by neighbourhood access to resources are the poor and less mobile.

Reynolds et al., (1997) suggests that it would be simplistic to assume that those who live near outlets actually use those outlets. Reynolds et al., (1997) argue that it is necessary to examine the importance of a particular outlet to someone and how this influences the drinking of those living near alcohol outlets. They cite examples of those who prefer to buy cheap alcohol from a supermarket or a general store/dairy, or someone who wishes to visit a bar or tavern in order to meet friends. While these theories suggesting the association between density of alcohol outlets and consumption are important, one important question that remains unanswered is why place only influences some sub-populations and not others?

Caution must be taken while interpreting these results because some may be the result of multiple testing and chance. While some of the results were significant with an alpha value of < 0.05, indicating that only 5% were by chance, there are results that are significant with an alpha value of < 0.001, showing that less than 1% were by chance.

9.4.2 Group differences in hazardous and frequent consumption

Why does place influence some sub-populations and not others? The discussion will examine each of the significant results independently by examining reasons why ‘‘place’’ features were important for the different sub-groups beginning with older males aged 75 and over, and young Māori and Pacific Island males aged 15-24. Reasons for non-significant results amongst younger Māori and Pacific Island females and male Europeans aged 15–24, will be highlighted. The discussion will then focus on other sub-groups including European females aged 15–24, Māori and Pacific Island females aged 25–34 and 45–54, European males aged 55–64 and rural males and females.

Why are older people 75 and over more likely to consume hazardously when living closer to alcohol outlets?

The results show that there is a negative association of males aged 75 and over who consume alcohol hazardously and distance. As distance increases hazardous consumption decreases showing that older males living closer to alcohol outlets have higher odds of hazardous consumption. Older people are more likely to be influenced by neighbourhood factors because of ageing and the physical challenges that often come with ageing. This might make older people more sensitive to their surroundings (Glass and Balfour, 2003, Robert and Li, 2001).

Older people who have lived in certain communities for a long time may have strong identities within such communities and tend to go to local retail outlets for most of their needs. Such a strong community identity includes purchasing or drinking alcohol from the nearest outlet, since at times they are on first name familiarity with the barman or even the owner of the bar. A community’s strong identity is normally enhanced by social interactions that occur at the local retail outlets, where most things are discussed, especially by older people whose life revolves around their locality (Day, 2008) Because of their age, older people’s residential communities are probably their most important environments because the spatial use of resources declines with age (Lawton, 1977). Lawton argues that older people are no longer exposed to other contexts such as work, thus relying mostly on community resources. Studies have shown that access to services is crucial for older people in the neighbourhood and accessibility to stores, restaurants and public transportation is important, those who move out of neighbourhood often cite inaccessibility to such services and lack of human contact (Brody, 1979, Carp and Carp, 1982)

Moreover, those aged 75 and over, even if they have cars, they are less likely to drive far and are more constrained within their neighbourhoods. People with limited mobility are therefore unable to access goods and services in other areas and are more likely to use the resources within their neighbourhoods more (Clifton and Lucas, 2004). Lawton (1977 p 278) summarises: “From a fairly large body of material on resource use by elderly, the conclusion is that the shorter the distance between a subject and a resource, the greater the likelihood that they will use it”. Most services in New Zealand, as explained earlier, are in the same commercial areas and services such as supermarkets and general stores/dairies offer both alcohol and food.

Why are younger males and Māori and Pacific Island people aged 15-24 more likely to consume hazardously when living closer to alcohol outlets?

Saggers and Gray (1998) argue that the culture of consuming potent liquor is partly to blame for the drinking habits of indigenous people, in both Australia and New Zealand, of buying large quantities of alcohol and consuming them quickly. This may be a reason why ethnic minorities living in closer proximity to alcohol outlets drink heavily. Furthermore, most commentators affirm that prohibitions against Māori, barring them from entering and consuming alcohol in outlets as well was membership in working men’s club led to the consumption of more potent alcohol. Māori were marginalised, alienated and stressed thus relied on illicit liquor, which was consumed excessively (Hutchins, 2009, Saggers and Gray, 1998). Māori and Pacific Island people consume alcohol hazardously more than all the other ethnic groups and such drinking has been linked to historical consumption and more particularly, Māori alcohol consumption can be linked to the first settlements at the Bay of Islands. It is reported that in 1830, some Māori chiefs expressed concern about the extent of consumption and asked for controls on alcohol availability (Hutchins, 2009). Mancall et al., (2000) argue that it was not all Māori consuming alcohol excessively but certain ‘*iwi’* (tribes), ‘*hapu’* (sub-tribes) or ‘*whanau’* (sub-groups). However, Hutt (1999) disagrees with Mancall et al., (2002) and suggested that Māori resisted alcohol in colonial times and were therefore not heavy consumers.

Other reasons for Māori and Pacific Island people's higher odds of hazardous consumption when living in areas with better access to alcohol outlets nearby include poverty and less mobility. They are constrained within their neighbourhood, since 20.9% of Māori have no car compared to only 6.6% non-Māori (Kjellstrom and Hill, 2002). Mobile people can choose where they drink and since the younger Māori and Pacific Island people are poor and less mobile, they are more likely to be strongly influenced by their neighbourhoods. This is further exacerbated by the fact that Māori and Pacific Island people tend to live in poorer neighbourhoods which often have a higher density of outlets leading to increased opportunities for alcohol consumption (Howden-Chapman and Tobias, 2000, Robson et al., 2007). Such opportunities have increased Māori and Pacific Island people's hazardous consumption (up at 39.1% compared to Europeans at 18.7%). Neighbourhood effects are mostly felt strongly by those who are poor or immobile such as some younger and older people (Kobetz et al., 2003, McNeil et al., 2006, Robert and Li, 2001), a pattern that is consistent for minority ethnic groups worldwide.

Māori and Pacific Island people's drinking tends to be clustered around outlets in deprived areas with those living closer to alcohol outlets having similar behavioural tendencies, compared to those living further away. People living in deprived areas are more likely to be influenced by common alcohol behaviour norms around outlets. Gruenewald (2007 p 870) argues that "alcohol outlets are environmental features of communities that expose populations to opportunities to drink and socially model other's behaviour", a theory well supported by Duncan et al., (2002) and Reboussin et al., (2010) who found that underage drinking in the USA is clustered around community features.

Māori and Pacific Island people aged 15-24 years are sometimes in a state of *'anomie'* or normlessness and might lack self-control when they are surrounded by alcohol outlets around areas where they live, and therefore drink excessively. A study examining differences in mortality for alcohol related deaths in Liverpool and Glasgow, two most deprived areas in UK, also suggested societal breakdown as a probably reason for differences in two areas with similar characteristics (Walsh et al., 2010). Māori and Pacific Island people living in deprived areas have been linked to the changing of strong social norms by acculturation, colonisation and rapid urbanisation, and this has led to the creation of new norms centred on alcohol outlets and excess consumption. While Māori and Pacific Island people were living in rural areas or in their erstwhile island homes, there were strong social controls. These have been lacking in urban areas following migration and after acculturation, leading to the creation of new norms. Te Ara (2009) states that in small rural communities everyone knows what everyone else was doing leading to close knit relationships, which resulted in a certain degree of social control. However, once in the city there is confusion about new norms and as such, people were in a state of *'anomie'* (Saggers and Gray, 1998). In the absence of the usual social control norms, the norm of excessive drinking in urban areas escalated as more and more indigenous people settled in the most deprived areas (Saggers and Gray, 1998). Obesity studies have also shown that those without self-control are more likely to be influenced by better access to fast food outlets (Inagami et al., 2006). After migration to the city many young people feel alienated, stressed, and suffer from a lack of self-control. This cultural milieu, coupled with the easy opportunities for drinking because of the many alcohol outlets, led to excessive alcohol consumption which often occurred in outlets within such neighbourhoods. Additionally, social capital can be health damaging as well as health promoting. The collectivism of indigenous people encourages reciprocity which means that if someone buys you alcohol today, it is your turn to buy it for them in the future. There are suggestions that the pressure on peers to remain drinkers is also strong because of the nature of reciprocity (Watson et al., 1988).

Younger Māori and Pacific Island people's consumption in close proximity to alcohol outlets is linked to different ways of accessing alcohol. Young people who are under the drinking age hang around neighbourhood alcohol outlets asking older patrons to purchase alcohol for them in what is referred to as 'shoulder tapping'. People in the most deprived areas are more likely to agree to buy for underage drinkers than those in more affluent areas (Chen et al., 2009), suggesting a link between density and outlets for underage drinkers, especially in the most deprived areas with many alcohol outlets. People in such areas were more likely to take a risk than those in affluent areas. However, other researchers have found that parents and peers were the main sources of supply (Hearst et al., 2007). Chen et al., (2009) argue that areas with higher densities of outlets had an association with supply, especially from parents, because some low income youths were unable to purchase alcohol directly from commercial stores as they did not have money. Supply route is an important determinant of younger people's consumption in areas with higher density of alcohol outlets.

There are concerns that availability of alcohol in supermarkets after 1989 in New Zealand, not only made alcohol available nearby, but also reduced prices significantly thus resulting in more sales of wine and beer (Hill and Stewart, 1996, Stewart et al., 1997). Since many outlets are located in the same areas, to maintain a niche in the market resulted in price wars, thus making alcohol available at close distance and cheaply. Furthermore, local alcohol availability further reduces the individual's travel costs. While this study did not examine the impact of price upon alcohol purchase and consumption, cheaper alcohol within closer proximity encourages excessive alcohol consumption. The issue of cheap prices, mostly in off-licences, has been cited as one reason for pre-loading (Withrington, 2007). This echoes patterns noted in food, diet and obesity studies which found that cheap food, high in calories, is sold around poor neighbourhoods and also in schools (Utter et al., 2009). Healthy food, meanwhile, is more expensive in deprived neighbourhoods than it is in affluent neighbourhoods (Inagami et al., 2009).

Most advertisements and billboards are also concentrated in deprived areas encouraging consumption and using advertisements that show that drinking is 'fashionable' or 'trendy'. Alcohol advertising is therefore an important influence on younger people's drinking. (McCreanor et al., 2008 p 944) wrote that "the synergistic cumulative effects of environmental exposure of young people to alcohol marketing creates and maintains expectations and norms for practises of drinking to intoxication.' This statement resonates with the WHO argument that the new culture of drinking is to get drunk (WHO 2004). Advertising therefore becomes normative and an important part of peer culture creating pressure to conform, especially those with strong bonds and who belong to a minority ethnic group. Advertisements might encourage consumption, but it is alcohol outlets that are heavily concentrated in some areas that encourage excessive drinking, especially amongst young homogenous groups, because during promotions such as 'happy hour' or 'buy one get one free', the young people can alternate quickly between the bars (Jernigan et al., 2006).

Why is there a gender difference between younger male and female Māori and Pacific Island people aged 15-24?

It is noteworthy that even though the difference between younger Māori and Pacific males and females aged 15–24 for hazardous consumption was 12% that is (59.9% (CI 52.5–67.2) versus 47.6% (CI 41.7–53.5) only male consumption has an association with distance. Further analysis, by examining the confidence intervals of the association between hazardous consumption and distance, showed that female consumption is more varied than males depending on location. The odds ratios and confidence intervals of females were larger (e.g. distance >2.2kms, OR 1.83, CI 0.70–4.75 (not significant) than males OR 0.27, CI 0.08–0.90, $p < 0.03$), after controlling for all confounding variables. This illustrates that women's hazardous consumption is more varied within the four distance quartiles and their confidence intervals overlapped with the reference group, while for men there was no overlap. Such differences are probably an illustration that there are more 'place' effects on men than women. While men's consumption is almost the same at both the shorter and longer travel distances, this was not true for females. Explanation was therefore sought for this occurrence. Cullen (1984) argues that historically, Māori women were prohibited from drinking, and he notes that it was also women who led the temperance movements during colonial times to stop their husbands from drinking. However, despite such differences Māori women were more likely to consume hazardously despite their location. Therefore, the gender differences possibly reflect the fact that women are more likely than men to choose where they drink and plan accordingly. Women make more choices about what resources to use than men, if they have a wider variety of outlets to choose from, a fact that has been observed in physical activity and obesity (Brodersen et al., 2005, Norman et al., 2006), smoking and alcohol consumption in other countries (Harrison et al., 2000, Hussong, 2000, Merrill et al., 2000, Willner et al., 2000). Women therefore prefer to make choices from among a number of resources while men prefer the nearest resource (Gomez et al., 2004, Jago et al., 2006).

Why are there differences between younger male Māori and Pacific Island people and New Zealand Europeans at ages 15–24?

Alcohol behaviour is not 'clustered' amongst younger New Zealand Europeans males aged 15–24 because not much clustering of behaviour is experienced in affluent areas, meaning that their behaviour is not the same around alcohol outlets as their Māori and Pacific Island counterparts. Further in-depth analysis of NZHS (2006.07) found that the proportion of New Zealand European males aged 15-24 consuming hazardously was 30.9% (CI 24.2–37.7). Similar to Māori and Pacific Island females, confidence intervals were larger when consumption and distance were estimated in regression (e.g. distance >2.2kms, OR 1.67, CI 0.45–6.26 (not significant)) (See Table 7.13), meaning that as distance increased, consumption varied from those consuming alcohol less than the reference group, to those consuming six times more. Such large confidence intervals show that drinking within the distance quartiles were varied and not clustered. Christakis (2007) found that obesity is also clustered around social networks arguing that behaviour is shaped by neighbourhoods; this clustering is probably lacking in New Zealand European neighbourhoods but stronger in Māori and Pacific Island neighbourhoods.

The other difference between the two groups is that Māori and Pacific Island people are over-represented in deprived areas, thus having more opportunities for alcohol consumption than their New Zealand European counterparts (Howden-Chapman and Tobias, 2000, Robson et al., 2007). Further analysis of NZHS (2006/7) data indicates that of all the people interviewed, only 14.8% of New Zealand European males lived in deprived areas compared to 41.9% of male Māori and Pacific Islanders, showing that the latter are over-represented in areas with easier access to, and with a greater density of, alcohol outlets. A comparison of drinking patterns between Māori and Pacific Island people and non-Māori showed that Māori have different patterns and are more likely to consume hazardously when compared to non-Māori (Bramley et al., 2003b, Huakau et al., 2005).

Moreover, New Zealand Europeans are not constrained in their neighbourhoods. They tend to be more mobile as only 6.6% lack access to a car, this is lower than the national average of 8.1% and much lower compared to Māori rates of 20% (Kjellstrom and Hill, 2002). Car ownership is associated with greater mobility and people without cars are unable to access goods and services in other areas, and are more likely to suffer from social exclusion as well as being more strongly influenced by neighbourhood features (Clifton and Lucas, 2004). Even though alcohol consumers sometimes pool cars, Europeans have more cars to pool than Māori and Pacific Island people. More White Europeans live in affluent areas with less ready access to alcohol outlets.

There are suggestions that cultures defined by collectivism and individualism also explain differences between Māori and Pacific Island people and New Zealand Europeans. Different cultures rotate around groups or individuals (Triandis, 1993). On one hand, not many studies have examined whether New Zealand Europeans are more individualistic, and research conducted in predominantly White European countries, including New Zealand, confirms this state (Triandis, 1993). On the other hand, Māori and Pacific Island people have a strongly collectivist cultural base. The latter relate more to family, relatives or other members of their ethnic groups, they share certain norms and prefer living in common areas and doing social things together, hence behaviour clustering (Carter et al., 2009, Richardson et al., 1988). Residential segregation located many more Māori in deprived areas than Europeans (Howden-Chapman and Tobias, 2000, Robson et al., 2007), thus giving them ready access to many alcohol outlets. Therefore, one probable reason for the lack of neighbourhood effects on male Europeans aged 15–24 is the strong individualism of European culture.

Another reason for differences between younger age groups of different ethnicity is in how stress is perceived and the fact that the types stressors for people living in affluent neighbourhoods are very different from the stressors of those living in the most deprived areas, where there are many opportunities for alcohol consumption. A recent study in America found differences in stress and depression amongst White and black people. While blacks coped with stress by engaging in unhealthy behaviour, they were less likely to be depressed, while Whites who engaged in unhealthy behaviour were more depressed. However, for blacks, they had more chronic conditions because of unhealthy behaviour (Jackson et al., 2010). This study shows that different groups relieve stress differently and with different effects. This is also a possible reason for the difference in the distance effect on the two sub-populations of same age, because minority ethnic groups may use nearby alcohol outlets to relieve stress more than the other mostly European groups.

Why are European women aged 15-24, more likely to consume hazardously when living in areas with a higher density of alcohol outlets within 800 metres?

Another significant result was for younger European women aged 15–24 who were more likely to consume hazardously if they lived in areas with many outlets within walking distance. The results showed that they have four times higher odds of hazardous consumption if living in areas with seven or more outlets, compared to those of a similar age and gender who live in areas with no outlets. The association between young European women's hazardous consumption and density is attributed to their consumption patterns, choice of beverage, use of local resources and the impact of advertising.

One probable reason why young European females are influenced by 'place' is because they can choose which alcohol outlets to patronise based on their preferred beverage. These might not necessarily be the closest outlets but they will be somewhere in the vicinity. Wechsler et al., (2002) suggest that those who drink frequently may be more aware of alcohol outlets around them, and the types of beverages sold. There are commentators who suggest that women are more likely to purchase alcohol or tobacco if they have a wider variety of outlets to choose from (Merrill et al., 2000 , Willner et al., 2000). Similarly, researchers such as (Brodersen et al., 2005) and (Norman et al., 2006) found that the quantity of resources in a neighbourhood was associated with girls' physical activity. Women tend to rely on neighbourhood resources for healthy eating and physical activity (Giles-Corti and Donovan, 2002, Harrington and Elliott, 2009, Reidpath et al., 2002, Stafford et al., 2007), this may also be a reason why they tend to rely on more local alcohol outlets for consumption.

Another reason for significant density measures for women is because women are more likely to purchase things from commercial stores within their neighbourhoods, showing that the supply route is also important. Hearst (2007) found that younger women relied on an alcohol supply from older boys of legal age who were their dates. However, Harrison et al., (2000) and Hussong (2000) in earlier studies, reported that women mostly purchased their alcohol from commercial stores, probably explaining why some females' alcohol consumption has an association with access to alcohol outlets. Similarly, if women lived in disorderly neighbourhoods, they would consume more alcohol (Hill and Angel, 2005), leading to an assumption that areas with many outlets in

New Zealand may constitute disorderly neighbourhoods. Areas with disproportionately higher number of outlets are considered disorderly (Sampson and Raudenbush, 2004, Stark, 1987). Ellaway et al., (2008) also found women smoking to increase based on their perception of neighbourhood availability.

McCreanor (2008) adds that women who remembered an advert were most likely to consume the advertised alcohol and possibly such advertisements led to them choosing outlets on the basis of the advertising. Probably those who remember advertisement were more likely to consume alcohol nearby, hence the significant results found in this study, only when they are based on straight line Euclidean distances. Among European women aged 15–24, hazardous consumption is still low but it is rising. This group has had the highest increase in alcohol consumption since the 1990s and this is suggested to be because of the introduction of alcopops and advertising (WHO 2004). Similar to Māori and Pacific younger males, women were more likely to look for cheaper prices and choose the alcohol outlet and beverage based on price.

Why are Māori and Pacific Island women aged 25-34 and 45-54 more likely to consume hazardously/frequently when living in areas with a higher density of alcohol outlets within 3000 metres?

Similar to younger Māori and Pacific Island men discussed first in this section, the women show higher odds of consuming alcohol frequently or hazardously when living in areas with many alcohol outlets. Māori women were more likely to be poor and therefore live in areas with many alcohol outlets to choose from. Similar to other women in obesity research, Māori women were more likely to rely on neighbourhood resources. Māori and Pacific Islanders of both these age groups are therefore more likely to drink within their neighbourhood (Merrill et al., 2000 , Willner et al., 2000).

As with Māori and Pacific Island men, there are strong neighbourhood cultures relating to consumption in deprived areas. Since a substantial number of these women are welfare beneficiaries (Barnett et al., 2004) they are more likely to be living in deprived areas. Access constraints are therefore felt by women of minority ethnic groups who are ‘locked in’ their neighbourhoods. These women are more likely to be at home caring for children and therefore less mobile and more likely to have to use local resources. Māori women have higher fertility rates, are more likely to be lone parents than European women, be unemployed and therefore more likely to have a strong local focus and use local alcohol outlets (Chapple, 2000). Robert and Li (2001) argue that home makers are more likely to spend a lot of time within their locality.

Why are European men aged 55-64 more likely to consume hazardously/frequently, when living in areas with higher density of alcohol outlets within 3000 metres?

Other significant results were for European males aged 55–64. Middle aged European men living in neighbourhoods that have 1–13, 14–37 and 38+ outlets have 9.6, 10.2 and 11.2 higher odds of hazardous consumption respectively, compared to people of a similar age living in areas with no outlets within a radius of three kilometres. Most studies have not studied this age group in relation to their alcohol use so the reasons for this pattern are somewhat obscured. This is a relatively ‘young’ age for European men because life expectancy is much higher in New Zealand, especially for Europeans. Normally those within this age-range are fairly mobile. Some potential reasons for the significant result may lie in the fact that they are settled with most owning homes, cars and having employment, they are therefore able to afford more alcohol and the cost of driving to the nearest outlet for consumption.

Middle aged European men aged 55-64 are more likely to have a strong neighbourhood identity. They go to the same grocery store, barber and even alcohol outlets. They are, therefore, more likely to buy and consume alcohol within their own neighbourhoods. Since they are relatively mobile, they could drive to their favourite places for shopping or socialising. The definition of neighbourhoods has been one major limitation of ‘place’ features research (Flowerdew et al., 2008). More research is needed to understand the reasons why male Europeans aged 55-64 are more likely to consume hazardously if living in areas with many outlets within a driving distance of 10 minutes.

Why are their gender differences of hazardously/frequent consumption in rural areas when living in close proximity to a higher density of alcohol outlets?

Rural males and females have dissimilar but statistically significant results. While rural females’ consumption was more likely to have an association with distance, both rural males and females have significant associations for consumption and density of alcohol outlets. As expected, rural males’ consumption increased with distance. Chapter 6 indicated that travel distances to alcohol outlets in rural areas were longer than those in urban areas. Despite the longer distances, rural females were more likely to consume hazardously when living closer to alcohol outlets. Those living furthest away (>2.2 kilometres) were less likely to consume frequently compared to those living closer to alcohol outlets. The differences here can be attributed to occupations. Since there are fewer economic opportunities in rural areas, women are more likely to be homemakers compared to men and therefore rely on local resources. This explains why men's consumption increased as distance increased while women's consumption reduced. Moreover, there are studies that have shown that in rural areas men are more likely to use pubs as social spaces more than women and travel considerable distances (Valentine et al., 2008).

Both rural men and women had an association with density of alcohol outlets. As for the relationship of women's consumption and the density of alcohol outlets, other research has shown that having many retail outlets to choose from influences women's physical activity (Brodersen et al., 2005, Norman et al., 2006). It maybe that rural women with many outlets to choose from are more likely to make use of their greater opportunities and choice of places to drink. As mentioned earlier, women are more likely to rely on neighbourhood resources, especially if they are home makers. Obesity research showed that women in closer proximity to healthy food outlets relied on such outlets for their food (Giles-Corti and Donovan, 2002, Harrington and Elliott, 2009, Reidpath et al., 2002, Stafford et al., 2007).

For both men and women, rural areas have strong community identity and networks, such strong networks can sometimes lead to clustering of behaviour (Pampalon et al., 2007). Stead et al., (2001) found that strong community identities and networks were related to smoking, so possibly a strong network in rural areas is also associated with consumption for rural men and women when they have many outlets to choose from, since they all have similar behaviour. This research did not examine specific geographical locations; however, buffer measures could capture the number of outlets that are within independent urban areas, and therefore people living within walking or driving distance in rural areas adjacent to urban centres could have many outlets to choose from which are not necessarily within rural areas. Such outlets expose people to opportunities for more consumption, hence the significant results. For both men and women, not many rural areas have access to a wider variety of alcohol outlets within 800 metres or 3000 metres, therefore those who have are probably living next to satellite towns, where alcohol is readily available giving them many opportunities to drink. Rural areas are mostly farmlands where labour varies according to season. While this study did not examine different seasons, maybe during seasons when there is reduced labour, those with access to many alcohol outlets consume frequently.

9.5 Access and density in relation to social outcomes

9.5.1 Density of alcohol outlets and hospitalisation

Analysis was undertaken to examine the relationship between the density of alcohol outlets and hospitalisation and results presented in Chapter 8. After controlling for a range of confounders it was found that the density of alcohol outlets, by type or category, is a predictor of hospitalisation. The study found that 'all alcohol outlets' predicted 30% of the total explained variance in hospitalisation rates. Similar results were reported in a study undertaken in California, where after controlling for a range of population and 'place' characteristics, alcohol outlets predicted 22.8% of the hospitalisation variance which was about a third of the total explained variance (Tatlow et al, 2000). However, there are some types and categories of alcohol outlets that are predominant in certain places as illustrated by the results in Chapter 6, therefore it is important to separate the outlets by category and type and each of these are discussed separately below.

The density of alcohol outlets, separated by different categories and type, predict rates of hospitalisation. For instance, on-licences contributed to approximately a third of the total *explained* variance in hospitalisation for both New Zealand as a whole and for urban areas respectively. This is similar to results in a study conducted in California (Lipton and Gruenewald, 2002). Off-licences on the other hand predicted only a quarter of the total *explained* variance for New Zealand and urban areas. When the analysis was further stratified by the density of supermarkets and general stores/dairies, this explained a quarter (5.9% and 8.9%) of the total variance (26.3% and 28.2%) in hospitalisation in the whole of New Zealand and in urban areas respectively. Similarly, the density of bottle stores *explained* almost 20% (4.7% and 6%) of the total explained variance (25.1% and 25.3%) in hospitalisation rates for similar areas. The *explained* variance in hospitalisation for rural areas was less than 1% for both supermarkets and bottle stores, but the results for bottle stores did not reach significance. Even though the variance predicted by alcohol outlets ranged from 20-30% of the total *explained* variance, the density of alcohol outlets has a relationship with hospitalisation. These results are consistent with crime and drink driving research, that has established that different types and categories of outlets predict hospitalisation by separating the outlets and identifying which outlets contribute most to risk and therefore the excess burden of hospitalisation (Gruenewald et al., 2006, Gruenewald et al., 2002). Suffice to note that within the international and local literature, little research has been done on the relationship between alcohol outlets and hospitalisation.

The relationships between hospitalisation and alcohol outlets vary significantly between urban and rural areas. The density of alcohol outlets predicts a larger portion of variance in hospitalisation in urban areas compared to rural areas and the whole of New Zealand. While the urban areas generally followed the national trend, the rural areas were different. In urban areas, after controlling for a range of factors including deprivation, off-licences and on-licences were all significant predictors of hospitalisation. People living in deprived areas (with many alcohol outlets, single parents, older people and those aged 15-24) are more likely to be hospitalised for alcohol-related disease.

The differences in urban and rural areas can be related to location of most outlets. While in urban areas, analysis in Chapter 6 showed that more outlets were located in deprived areas, as was the case when rural was defined as one category, but when separated into four classes, there was no clear gradient. Nonetheless, analysis in Chapter 5 had shown that those living in urban areas had a higher risk of hospitalisation. This probably explained the higher variances predicted in urban compared to the rural areas.

A number of explanations can be given for the above observations. The probable reasons for both urban and rural consumption in off-licences, including bottle stores, supermarkets and general stores/dairies are different. In urban areas, most people 'pre-load' from off-licences before heading into on-licensed places with most pre-loaders arriving in on-licences having consumed a lot of alcohol (Boyle et al., 2009, Withrington, 2007). This is because alcohol sold in off-licences, such as supermarkets and liquor stores, is generally cheaper than in on-licences (Withrington, 2007). For rural areas, which are considered relatively 'dry', a possible explanation could be that people tend to purchase alcohol in off-licences since the results in Chapter 6 showed that on-licences and off-licences are relatively far apart compared to those in urban areas. This probably results in stocking up on alcohol at home, and therefore more consumption at home. Generally, for both urban and rural areas, off-licences have no control over the amount of alcohol that can be purchased or consumed (Galloway et al., 2007), while in on-licences, drinking is controlled depending on an individual's state of drunkenness (Graham et al., 2005).

Reasons for consumption, notwithstanding, there are other issues to do with seeking of services in rural areas. Research has shown that those living further away from hospitals are less likely to seek treatment (Aday and Andersen, 1974, Bentham and Haynes, 1985, Haynes et al., 1999, Lovett et al., 2002). Rural people are less likely to attend hospital especially for alcohol related problems (Fortney and Booth, 2001). The urban/rural difference is important for intervention because it implies that 'dry' areas (fewer alcohol outlets) have fewer hospitalisations than 'wet' areas (many alcohol outlets).

Another reason for the explained higher variance in urban and not rural areas can also be related to location of alcohol outlets. Most outlets in rural areas are historical and located in old towns or small towns, while in urban areas outlets are located in commercial zones, which are concentrated in deprived areas. Other studies have shown that access to most resources including health services are better for those who live in deprived areas in New Zealand. Importantly, there is a link therefore between location of resources and health outcomes in individuals. Certain sub-groups living in areas with many alcohol outlets were more likely to consume alcohol hazardously and consequently be hospitalised. There are also suggestions that those with alcohol problems self-select and live in areas that are closer to alcohol outlets, so as to access alcohol more easily (Smith and Hanham 1982). While not much has been done on self selection, a community's socio-demographics cannot be entirely dismissed. There are other individual characteristics that predispose people to alcohol and alcohol related disease such as single parenthood and age (which is either an older person or those aged 15-24). These sub-groups are more likely to be hospitalised for alcohol-related disease. This is similar to what the results of alcohol-related behaviour and proximity to alcohol outlets revealed in regression analysis.

Most importantly, this study was able to show that the density of alcohol outlets, whether separated by type of category, predicts alcohol-related admission at the CAU level and answered the question that was posed in Chapter 4, whether alcohol outlets have an independent influence on hospitalisation after controlling for confounding effects.

9.5.2 Density of alcohol outlets and crime

While some studies have relied on predicting total crime (Gorman et al., 1998a, Gorman et al., 1998b), results from Chapter 8 found that the most of the variance of all violent crime combined and stratified by the 'place' where the violent crime occurred was predicted by alcohol outlets. Of significant importance is isolating the type of outlets that contribute most to different types of crime, something that has been previously ignored. The results showed that total alcohol density, as well as category and type of outlet had an association with hospitalisation. This study indicates that 'place' characteristics, more specifically the type and category of alcohol outlets, predict minor and serious violent crime. Each will be discussed separately below, followed by the reason for the observed relationship. This section ends by briefly discussing three theories linking alcohol outlets to crime.

There was conflicting evidence about the relationship between alcohol outlets and crime. There are some negative associations and in some cases there was no association between alcohol outlets and crime. For instance, for serious crime occurring at dwelling places, the regression coefficients were negative indicating that places with more serious crime occurring at dwelling places were associated with a lower density of all alcohol outlets. This suggests that that outlets may actually have a protective effect on dwelling crime. Additionally, density of on-licenses had no association with minor violent crime. Similarly there was no association between density of off-licenses and serious violent crime occurring at dwelling places. The results from this study showed that total serious violent crime was not predicted by total alcohol outlets as were two studies in New Jersey (Gorman et al., 1998a, Gorman et al., 1998b), and Chicago (Block and Block, 1995), which found no association between alcohol outlets and assault or domestic violence. This was in contrast to Scribner et al., (1995) who found that in California, after controlling for a range of socio-demographic factors, total outlets were related to violent crime. However, for this study when the results were stratified by places where crime occurred, there were some significant associations between total alcohol density and crime. This study found that the density of total alcohol outlets *explained* the highest variance in serious violent crime occurring at dwelling and licensed premises. For minor crime occurring at licensed premises the highest variance (almost 70% of the total explained variance) was predicted by the density of total alcohol outlets, consistent with results reported by Britt et al., (2005). Zhu et al., (2004) also found that (total) alcohol outlet density at census tract level in Austin and San Antonio (USA) was associated with a range of violent crimes. These results point to an association between a higher concentration of alcohol outlets and both serious and minor violent crime and should not be interpreted to mean that all outlets influence crime.

This study also examined the relationship between crime and type of alcohol outlet. When the outlets were stratified by type, the predictions varied; however, in most cases the density of alcohol outlets was the most important explanatory variable. Off-licences predicted more than half the total *explained* variance of serious crime occurring in licensed premises. Additionally off-licences predicted most of the total *explained* variance for minor crime occurring at licensed premises. Gruenewald and Remer, (2006) also found assault rates to be related to off-licences. For this study, off-licences predicted 2.9% variance of crime occurring at dwellings and confounder variables predicted 45%, showing that confounder variables predicted most of the *explained* variance, while there was no association between off-licences and serious violent crime, including homicides. This is in contrast to a study conducted in New Orleans, USA where the socio-demographic variables explained 58% variance in homicide and off-licences an additional 4% (Scribner et al., 1999). The difference in results can be attributed to geographical level of study, since the New Orleans study was at census tract level, a relatively smaller geographic area compared to TA areas in New Zealand, and sometimes large geographical areas mask severity of health outcome because of aggregation bias (Roman et al., 2008). While the effect of crime, for example, might be great in certain areas with many outlets, this reduces when the area is widened to include areas with both less alcohol outlets and crime. Additionally, while serious crime occurring at dwellings included homicide and other crimes, the New Orleans study only examined homicides, so probably the effect of off-licenses was confounded by other crimes in New Zealand.

In this study, the density of on-licences and the categories of off-licence supermarkets and general stores/dairies predicted most of the total explained variance of serious crime occurring at licensed premises. Freisthler et al., (2005) also found that bars had an association with violence, while Scribner et al., (1995) found that assaults were associated with both off- and on-licences. For minor violent crime occurring on roads, only bottle stores results reached significance. Other studies have shown that those most likely to commit crime on roadsides purchase alcohol from off-licences. This is mostly committed by people either pre-loading before going to on-licences within the city centres, or those who are just hanging around the alcohol outlets (Boyle et al., 2009, Withrington, 2007). Not surprisingly, for crime occurring in licensed premises, the on-licences predicted a higher proportion of the explained variance than off-licences for both minor violent crime and serious violent crime. Similar results were observed by Roman et al., (2008) who reported that a high density of on-licence outlets was related to aggravated assault, a serious crime. Suffice to say that alcohol outlets are not a problem as such, but when they are concentrated in certain areas of the community, there is an increase in both minor and serious crime. This result could be examined in the light of strict controls in on-licenses and those seen to be intoxicated asked to leave therefore limiting the level of consumption (Graham et al., 2005).

A number of explanations can be given for the above observations. People who buy alcohol from off-licences are more likely to consume alcohol in an open space or in cars around where the outlets are located. There is also no control on the amount they can consume. This pattern creates an opportunity for those who become aggressive after consuming alcohol to victimise others who may, or may not, be the worse off for having consumed alcohol (Roman et al., 2008). People tend to consume more alcohol in these unregulated environments and to commit minor violent crimes in dwellings, on the roadside or in public places (Withrington, 2007). It is not intoxication alone that is the problem, but having the offender and victim in the same area, that increases violent crime. Most on-licences are associated with crime occurring at licensed premises; however, even off-licences have a relationship with crime occurring in such places, raising the issue of people pre-loading before going to on-licensed premises.

There is evidence of a dose-response relationship with crime showing that there are other causes in addition to the presence of alcohol outlets (Corrao et al., 1999, Pridemore and Eckhardt, 2008, Wells and Graham, 2003). Bottle stores sell hard liquor which intoxicates people quicker, so the chemical reaction will be faster for people who buy and speedily consume alcohol in unlimited quantities. Excess consumption can lead to incapacitated behaviour (Reynolds et al., 1997), because alcohol's chemical effects can make someone violent; leading to aggression, even when normally they are not violent or aggressive (Huakau et al., 2005). Places with a higher density of alcohol outlets, provide easy access to alcohol for consumers, albeit moderated by price. In New Zealand, the lowest alcohol prices are found in off-licences, meaning that cheaper alcohol is available in close proximity for those living in deprived areas. This may result in excess consumption for some sub-groups as was evidenced in Chapter 7. Community leaders in Manukau City also report that excess consumption influences crime because of cheap liquor being available in areas that are already socio-economically deprived (Tahana, 2008). In addition, there is no control on the amount of liquor one can purchase and the amount that one can drink at or around off-licences.

Another explanation for observed result lies in the location of alcohol outlets in New Zealand. Alcohol outlets are mostly located within residential estates and in deprived areas. The density of liquor stores, whether separated by type or category, is higher in poorer areas with a high proportion of Māori, and therefore it is not a surprise that deprivation and the percentage Māori, explained some of the variance in crime. The results for access and consumption identified Māori and Pacific Island people as more likely to be affected by proximity; meaning that as distance to alcohol outlets reduces, they are more likely to consume excess alcohol. Areas with more Māori and Pacific Island people, which are predominantly the most deprived are also 'hot' spots for alcohol outlets and crime as well as for adverse consumption patterns. Māori and Pacific Island are reported to be more likely to be aggressive and violent after consuming alcohol, which is a probable reason for a significant increase in crime around outlets where such groups predominate in the local population (Huakau et al., 2005). Crime is not necessarily related to consumption, but to alcohol outlets and this relationship has been explained by three inter-related theories relating to social disorganisation, self-selection and crime potential.

The social disorganisation theory states that in unstable and poor neighbourhoods violent crime is most likely to occur because outlets are perceived as areas of violence, a situation mostly found in areas with high unemployment rates, and in deprived areas with many outlets (Gruenewald et al., 2006). Outlets in poor areas are often seen as places where violence is common. Also, areas where violent crimes are the most likely to occur are disadvantaged neighbourhoods predominantly inhabited by Māori and Pacific Island people. Although there are clearly exceptions and local research is important, many socially disorganised neighbourhoods often share particular characteristics, such as graffiti, litter, low quality housing, broken bottles and above average numbers of alcohol outlets (Sampson and Raudenbush, 2004). People living in such areas are therefore more likely to indulge in, or be the victims of, crime around alcohol outlets as well as other alcohol-related harm, because of a lack of collective efficacy (Morenoff et al., 2001, Sampson et al., 1997). As Grunewald and Remer (2006, p 675) put it, bars are having an 'undifferentiated social influence upon people living and socialising within such neighbourhoods'. While this explanation could be compositional, it has been used by most studies to explain the link between the density of alcohol outlets and crime

The second theory relates to social selection. This theory suggests that individuals in neighbourhoods may use alcohol outlets differently. Outlets in violent neighbourhoods may become violent places (Gruenewald et al., 2006), a situation which is mostly found in deprived areas with high unemployment rates. Outlets in quiet, mostly rich neighbourhoods may be places for meeting and relaxing and have little or no violence since the outlets and areas around them are perceived as safe places (Reynolds et al., 1997). People may therefore select an outlet to socialise in based on their perception of violent or non-violent outlet.

Additionally, this study found that areas which were the most deprived and had a significant proportion of Māori and people aged 15-24 in the population were more likely to have outlets that are related to crime, even though the crime rates were very low. Suffice to note that while the unemployment rate for all people in New Zealand was 6.4% in March 2010, Māori rates were double that at 13.3%, the highest in many years. Another measure of youth inactivity is known as 'Not in Employment, Education or Training' (NEET). Māori males and females aged 15-24 years were 19.8% and 15.5% NEET respectively, compared with 11.6% of all males and 9.8% of all females in this age group (Department of Labour, 2010). Similarly a significant number, 11.8% of

New Zealand Europeans aged 15-24, were also not employed. It is probable, therefore, that since deprived areas with many outlets are perceived as rough with many young people, both Maori and non-Maori, hanging around, such places may be more prone to violence. On that basis crime may be seen as occurring as a result of how the area is perceived because of its social characteristics.

A third explanation is the crime potential theory (Gruenewald et al., 2006). Crime potential theory states that it is sum of the outlets and other characteristics that contribute to crime, by providing opportunities for many people to be in certain areas either at night or during the day. The results from this study in Chapter 8 found that alcohol outlets contribute significantly towards violence over and above other factors, as they provide opportunities for aggressors and risks for potential victims. Alcohol retail outlets such as bars, liquor stores, general stores/dairies and supermarkets attract people of different socio-demographics who are both aggressors and potential victims to one area. Moreover, people who are unemployed who live in deprived areas might hang around such alcohol outlets without any particular reason but simply because there are many outlets in their area, presenting them with many opportunities for crime or unwittingly being at risk of becoming a victim of crime.

These results and discussion answer the question whether there was an independent effect of alcohol outlets by type and category on crime. 'Place' effects predicted a significant proportion of the total explained variance and must not be overlooked in crime policy. While outlets are important, the total *explained* variance by both outlets and control variables in most cases was less that 40%, meaning that there are other factors that are also important in predicting crime occurring around outlets. As Reynolds et al., (1997) suggested, we need to examine who use the outlets and the conditions of outlets to really understand the connection between outlets and crime.

9.6 Study Limitations

The first two study objectives examined mortality and hospitalisation data. A critical assessment shows that some diseases such as cirrhosis of the liver and pancreatitis can also be caused by hepatitis B and mumps, few cases are solely caused by alcohol, thus at times over representing them. On the other hand, this analysis was unable to control for individual income or social class, an important variable in health because most of the information on occupation was missing from the data available. Apart from missing data, the geographical scale was also a limitation because data could only be analysed at CAU level thus masking important differences at meshblock level. It is worth noting that the relationship between variables may change when they are measured at different spatial scales, such that the results presented here for hospitalisation and mortality might change when spatial scales are different (Exeter and Boyle, 2007, Flowerdew et al., 2008, Openshaw 1984).

The third objective examined access to resources. Criticisms of measures of access to resources include the assumption that people will visit the nearest alcohol outlet and will also be commencing their journey from their homes with population centroids as a proxy, yet people may well start their journeys from their workplaces or elsewhere. Caution must also be taken when interpreting straight line Euclidean distances within buffers because they may extend over obstacles and the alcohol outlet, which while theoretically within walking or driving distance, may not be so in reality (Witten et al., 2003). Euclidean distances were used as they represent areas within a catchment area, over and above administrative units (Pearce et al., 2006). Apparacio et al., (2008) also suggest that population-weighted centroids in rural areas might not give accurate calculations when compared to urban areas because of the scattered nature of the rural population, so rural densities and distance should be treated with caution. In rural areas, geo-coding along highways may not be accurate thus sometimes locating outlets inaccurately (Hay et al., 2009). There are also limitations for the fourth objective, examining access to alcohol outlets and alcohol-related behaviours. As explained in Chapter 6, some areas had 10 times more outlets in the most deprived areas than in the least deprived. For example, the West Coast of the South Island (New Zealand) with its traditionally higher rates of alcohol outlets has fewer people per outlet, as well as shorter distances to travel to an outlet. The study could not analyse data in such specific geographical areas such as regions, DHBs or TAs, despite the distribution of outlets and consumption varying from one geographical area to another. This inability to study small geographic areas within larger geographical areas is probably a reason for the modest area effect nationally. All the analyses were undertaken at a broader country level. Additionally because of confidentiality issues when obtaining data, separation of on- and off-licences was not possible. This meant the study could not examine which one of these outlet types contributed most to the burden of hazardous consumption. Data confidentiality limited further analysis that would have shown the effect of the different types of outlets, specifically examining how supermarkets contribute to hazardous consumption. Recent studies in New Zealand have pointed to an increase in sales from supermarkets as well as the fact alcohol products are competitively priced in supermarkets. For example, with the change in legislation in 1989 and 1999 (Sale of Liquor Act), purchasing from supermarkets was allowed which is suggested to have improved availability both in price and proximity. This competitive pricing from supermarkets and other outlets is suggested to increase drinking (Treno et al., 2006).

Measures of distance to alcohol outlets do not necessarily mean that people purchase alcohol from the nearest identified outlet; therefore there is a need to investigate where people actually buy alcohol and the places where it is consumed. Moreover, this study examined access to alcohol outlets and not actual alcohol purchases. The price of alcohol is important since it is suggested to be a determining factor for people of lower socio-economic status.

For the analysis of consumption using NZHS 2006/07, distance measures were chosen based on confidentiality requirements which were that all distances be in categories rather than continuous, and in four equal quartiles each having approximated 9600 meshblocks. The shortest distance was 0–571metres followed by 572–996 metres, then 997–2160 metres, and finally over 2161 metres. When further analysis was done by combining the first two distances or the second and third quartile distances, the results still remained the same with no major change. Joseph and Phillips (1984), who focussed more on access to health care, suggest that it is important to take into account the size and popularity of community resources and their location. Some remote rural locations may have stronger distance decay than urban areas. They add that “distance decay effects will not be perfect because of the concurrent and complex interaction of spatial and non-spatial influences on utilization” (Joseph and Phillips, 1984 p 102). While this study measured access to alcohol outlets it did not take into account that there are outlets of different sizes and popularity or added weighting based on their importance and size. In addition, this study did not examine the relationship between access measures to a range of alcohol outlets by type and category as well as other factors that might affect consumption, such as prices, and the availability of people’s beverage of choice. Distance measures should take into account a range of variables when being calculated. A distance of one kilometre to alcohol outlet in the opinion of some would still be considered close to an alcohol outlet, therefore the distance chosen may have been limiting in understanding the influence of distance on alcohol-related behaviour. It would have been better to understand and choose the appropriate distance without the limitations imposed by data confidentiality.

Migration and length of residence in an area were not examined so it is not possible to determine whether existing consumption patterns were developed there or elsewhere. Migration is an important topic in 'place' since research has highlighted that health differences between neighbourhoods can be explained partially by selective migration (Brimblecombe et al., 1999, Boyle et al., 2002).

This research did not control for land use in New Zealand, since other studies have shown that most resources such as parks, fast-food outlets and recreation green spaces are mostly located in deprived areas (Pearce et al., 2006). This, in effect, means that both negative and positive resources are located in deprived neighbourhoods. Suffice to note that because of confidentiality issues, adding more variables to the data set proved difficult. 'Place' variables were restricted to access to alcohol outlets in this study. Chapter 3 indicated that there are a range of other 'place' variables that can increase or reduce consumption including: neighbourhood stress, social capital and cohesion and alcohol advertising. While analysing all these variables together may be beyond the scope of one thesis, controlling for some of these variables will no doubt confirm the theory that access to a variety of resources has an effect on health and contributes to health inequality.

Neighbourhoods as defined by a researcher using administrative boundaries or censuses (as in this study) may not be a true construct of the neighbourhood (Macintyre et al., 2002, Diez Roux, 2001, Tunstall et al., 2004). Most geographers always argued about what geographical area is truly representative of a neighbourhood and there are studies that have shown that the way a neighbourhood is defined influences the final result (Flowerdew et al., 2008) although other writers found no significant differences using alternative neighbourhood definitions (Haynes et al., 2008, Jones et al., 2010). This study relied on administrative neighbourhoods, which have been used by other studies. While the administrative boundaries might not be true neighbourhoods, most government data are collected based on administrative boundaries and this makes comparisons between two studies easier, however, these may not necessarily be true neighbourhoods.

The limitations of the fifth objective, examining density of alcohol and hospitalisation, were varied. While hazardous consumption leads to eventual disease, this study was able to assess only alcohol-related disease, thus under-representing those who drink hazardously but are not yet ill enough to warrant a hospital stay. While hospitalisations are a good proxy for consumption, cognisance must be taken of the fact that not all hazardous consumption is captured by using proxies such as hospitalisation. CAU are fairly large geographical areas compared to meshblocks and more analysis at meshblock level would be required to further understand the differences. All alcohol outlets were treated as having the same impact, however Roman et al., 2008 suggest that there are some outlets that have more influence than others and that research should use different weights for different outlets. For example, supermarkets sell more alcohol than general stores/dairies, but both are treated the same in this research. The variance explained by both control variables and the density of alcohol outlets or hospitalisation rates was low, with very high residuals showing that a number of confounding variables were missing from the analysis.

The final objective examined the relationship of the density of alcohol outlets and crime, with some limitations. Caution must be taken in interpreting crime results because TAs in New Zealand are large areas and include both urban and rural areas. Whilst most of the crime occurred in urban areas and towns adjacent to rural areas (e.g. New Plymouth), rural areas have fewer crime cases. An aggregation of total crime therefore reduced the power of alcohol outlets in predicting crime because of large geographical areas combined with the effect of rural and urban areas within a TA. Chapter 6 suggested that alcohol outlets vary by region and some areas, such as Westport, have higher densities for cultural and historical reasons. People congregate in certain areas to drink and crime increases because some people become criminally aggressive when intoxicated thus putting others at risk of becoming the victims of crime. Moreover, they might not necessarily be living in that community. A typical example is New Plymouth where the crime rates greatly exceed the total population within the area. Better information could have been obtained from data at the smaller geographical units of CAUs or meshblocks, but this was not available. Data at such a fine geographical level would also have improved the analysis of the relationship between distance to outlets and the locations where crime is occurring. The ecological framework may not adequately explain the link between crime and alcohol outlets (Gruenewald et al., 2006).

The police districts were not a good match with TA districts, therefore, based on the sizes of police districts within certain TAs, crime statistics were assigned to TAs proportionally. Such proportional assignments are not 100% accurate, indicating that some areas were either under-represented or over-represented. However, the results were validated as shown in Chapter 4, with minor differences between TAs that fully fitted the police districts and for all the TAs combined. The variance explained by both control variables and alcohol outlets in both minor violent crime and serious violent crime was low, with very high residuals showing that a number of confounding variables were missing from the analysis. Despite the low overall variance, alcohol outlets explained more than half of the total explained variances, indicating that outlets are important in understanding crime occurring at different places. There is a need to investigate neighbourhood social organisation, as well as social capital and cohesion as confounding factors.

Some methodological limitation includes using OLS, thus assuming that the relationships are linear which might not be the case. In addition, there could be bias because of unmeasured confounding variables as was seen with the large residuals. Heteroscedasticity is also a problem with OLS regression at times (Haynes and Gale, 1999). Similarly while most hierarchical studies have used multi-level modelling, this study used binary logistic regression. There are suggestions however that multi-level analysis gives more reliable estimates of the standard errors of regression parameters. Additionally, multi-level models have the capacity to divide the total variance into individual level variations and area level variations thereby recognising the dependent nature of the data values (Subramanian et al., 2003a). On the other hand multi-level models are fairly complex and more difficult to interpret (Diez Roux, 2003, Draper, 1995, Duncan et al., 1998, Haynes and Gale, 1999). Additionally, sensitivity analysis to check whether the rates are stable by changing distances or radius of buffers could not be undertaken because of strict confidentiality issues.

9.7 Conclusion

As this is a cross sectional study, it would be difficult to answer the question, which came first, alcohol outlets or alcohol-related behaviour and health impacts? Is it the presence of alcohol outlets that encourage Māori and Pacific Island people's hazardous alcohol consumption or is it that alcohol retailers are encouraged to locate in certain areas, such as those mostly inhabited by minority ethnic groups, because they know that people living there consume more alcohol than those living in other areas? Reverse causality cannot be entirely dismissed and studies show that each has an effect on the other. As Scribner et al., (2000) reported, neighbourhoods with easy access to alcohol outlets have heavier drinking norms which influences excess consumption, especially in high density outlet zones, which in most cases were also the most deprived areas. Smith and Hanham (1982) argue that the reason for high consumption in urban areas is because people living in rural areas who are heavy drinkers move to the cities to be near alcohol outlets. They argue that even within cities hazardous consumers may self-select to live closer to alcohol outlets. This argument can borrow from structuration theory (Giddens, 1984) which can be separated into structure and agency. Structuration theory recognises that social structures influence individuals' behaviour strongly and at the same time individuals' behaviour reproduces and transforms structures and has the capacity therefore to integrate people and places at the local level (Gatrell, 2002). To give a hypothetical example, alcohol outlets located within a deprived neighbourhood provide opportunities for easy access to alcohol; however, it is the ability of people to purchase alcohol that will lead to establishment and maintenance of alcohol outlets in such areas.

Despite the limitations, this study contributes to the debate of health inequality by examining the effects of 'place' on alcohol-related behaviour and going beyond statistical analysis to examine the theory behind the observed phenomena. Alcohol hospitalisation and mortality were examined as proxies and showed that deprived areas have three times more hospitalisations and mortality than more affluent areas. The NZHS (2006/07) showed that the highest consumption is in the most deprived areas, highlighting a need for further investigation. Recognising that measureable objective individual factors had been investigated and a gap still remained, access measures were developed, which also indicated that alcohol outlets are disproportionately located in the most deprived areas. Further analysis indicated that some sub-populations with easy access to alcohol outlets consume alcohol hazardously and are more prone to hospitalisations and crime. Additionally this research may also direct others into qualitative research, so as to investigate the role of place – especially in deprived areas with high number of alcohol outlets – in different ways. Explanations have been offered based on routine theory, social disorganisation theory and social selection theory. Most importantly, the research has indicated that neighbourhoods with many outlets have certain circumstances that predispose people to adverse consumption and/or crime.

The next chapter concludes by highlighting the key themes and the main contributions of this thesis as well as future research ideas.

Chapter 10 Thesis Conclusion

10.1 Introduction

Geographers have argued that to understand alcohol-related behaviour and subsequent health outcomes, contextual factors must be examined; however, they also acknowledge that individual factors are important (Scribner et al., 2000). Research examining place effects on alcohol related behaviour undertaken in contexts other than New Zealand has produced mixed results. Some studies have shown that excess consumption has a positive association with contextual factors measured by access to, or density of, alcohol outlets (Schonlau et al., 2008, Scribner et al., 2000), while others have shown that there is no relationship (Pollack et al., 2005). Such inconsistencies in results are likely to be determined by the characteristics of a particular place as well as limitations in study design or methodology. This thesis attempted to enhance results obtained from previous studies by developing access and density measures and relating them to individual alcohol behaviour. Chapter 9 demonstrated that access to, and density of, alcohol outlets offered a potential explanation for the links between neighbourhood deprivation and alcohol consumption as well as other social outcomes, such as crime. The aim of this chapter is to highlight the contribution of this thesis to the wider literature and relevant national policies.

This final chapter is structured as follows. The chapter begins by revisiting the aims and summarising the four key themes arising from this research and the contribution of each to the literature. The subsequent section highlights the key theoretical contributions of this thesis to 'place' research in health geography and briefly examines New Zealand policies on reducing alcohol consumption. Following thereafter are recommendations for policy changes with an emphasis on 'place' effects based on results of this study. Finally future research ideas are discussed.

10.2 Aim, objectives and themes

The main aim of this thesis was to determine the influence of 'place' effects on alcohol-related behaviour, and health and social outcomes in New Zealand.

Six research objectives were examined:

- to determine the geography of alcohol consumption in New Zealand using available proxy measures

- to examine the geographical variation in these proxies by age group, gender, ethnicity, rural/urban location and socio-economic status

- to develop measures of geographical access to alcohol outlets (off-licences and on-licences) for small areas in New Zealand

- to determine whether access to alcohol outlets makes an independent contribution to alcohol consumption after controlling for potential confounding factors

- to determine whether the density of alcohol outlets has an independent effect on alcohol-related hospitalisations after controlling for potential confounding factors

- to determine whether the density of alcohol outlets has an independent effect on crime after controlling for potential confounding factors.

A range of quantitative methods were used to examine these objectives and four key themes emerged from the results. First, there has been an overall increase in alcohol-related mortality (1994-2005) and hospitalisations (1999-2006) over time and these increases have been influenced by differences in age, gender, ethnicity, urban/rural location and most significantly by area deprivation. Results show that there is increasing geographic inequalities between the most and least deprived areas. The rates in the most deprived areas increased over time after controlling for a range of confounding variables. This research highlighted some of the potential reasons for the differences, such as increased hazardous consumption amongst certain groups, such as younger men and women aged 15-24 years, and further analysis was undertaken to examine whether the increase in inequality was because of contextual factors. This required the development of measures of access to alcohol outlets.

Secondly, this study successfully developed measures of access to alcohol outlets and found that there is inequity in availability of alcohol outlets in the most deprived areas which incidentally also have a higher number of minority ethnic groups. People living in the most deprived areas have to travel shorter distances to alcohol outlets and have a wider choice of outlets within close proximity. The measures developed show that there are many reasons influencing the location of outlets in certain areas including local policies, lack of strong social capital, land rate issues and cultural and historical issues. The knowledge of distribution of outlets in deprived areas was important, as the next step in the study was to analyse whether exposure to such resources had an influence on alcohol-related behaviour and social outcomes.

Thirdly, access to, as well as the density of, alcohol outlets explained alcohol-related behaviour in some sub-populations. Using the developed access measures and data from the NZHS (2006/07), binary logistic regression analysis showed that, both the density of, and distance to alcohol outlets had associations with frequent and hazardous drinking in some sub-populations but not others. For example, young Māori/Pacific Island people aged 15-24 years and elderly people aged 75 and over, were more likely to be poorer and less mobile, thus making them more likely to use local resources within closer proximity. There were also gender differences amongst the significant sub-populations creating a need to explain why such differences occur.

Fourthly, although the explained variance was often quite low for crime and hospitalisation, most of the former tended to be explained by the density of alcohol outlets, after controlling for a range of confounders. Each of these key themes will be discussed separately.

10.3 Key themes

10.3.1 Increases in hospitalisation and mortality over time and the influence of individual and contextual factors

The results showed that there was an increase in both hospitalisation and mortality over time which was driven by both individual and 'place' factors. Importantly, these results indicated that inequality between the most and least deprived areas increased over time. Using Poisson regression, this study was able to show that the gap between quintile one and five widened over time, despite a slight reduction in the gap between males and females. This result is consistent with New Zealand research that has highlighted the increase in health inequality. For example, differences in health outcomes for deprivation quintiles have worsened over time for smoking (Moon and Barnett, 2003), suicide (Pearce et al., 2007) and mortality (Pearce et al., 2008b). Significant increases were also observed in hospitalisation for all younger females and Māori females.

These results contribute to the literature in a number of ways. This research shows that alcohol is responsible for increased social polarisation in hospitalisation and mortality in New Zealand. The results therefore contribute to an improved understanding of the geography of alcohol consumption and one of the reasons why health inequalities are increasing. Suffice to note that this research was innovative in using only those cases directly associated with alcohol consumption as was done with studies in the UK (Harrison and Gardiner, 1999, Breakwell et al., 2007) and Russia (Pridemore and Kim, 2006). This is the first study in New Zealand to use such measures. Secondly, Robson et al., (2007b) argue that New Zealand population structure is different and therefore age should be standardised using the New Zealand population as standard. Therefore, a further contribution of this research lies in the robustness of the analysis. Mortality and hospitalisation rates were age-standardised using the New Zealand population as the standard, thus giving an accurate representation as opposed to using the WHO structure.

10.3.2 Inequity in availability of alcohol outlets

The results consistently show that in New Zealand there is inequity in the availability of alcohol outlets. There is a social gradient with increasing numbers of outlets, by both type and category, as area deprivation increases. In addition, the higher density of outlets in the most deprived areas means that alcohol is more easily accessible to people living in these areas. Similarly access was better in the most deprived neighbourhoods, with people residing in the least deprived areas having to cover twice the distance to an alcohol outlet. Similar results have been reported in other New Zealand studies (Hay et al., 2009, Pearce et al., 2008a) and also internationally (Pollack et al., 2005, LaVeist and Wallace, 2000). Spatial differences are also observed, where the concentration of outlets in the most deprived areas is evident, in both urban and rural New Zealand, as well as in different regions. Although the distances to alcohol outlets are slightly longer in rural areas, the social gradient still exists with an ever increasing number of outlets as area deprivation increases, no matter the geographical area. Areas with higher alcohol outlets are therefore ‘intoxigenic’ environments, a term coined by McCreanor et al., (2008) to describe areas where problem drinkers and drinking are produced.

The strength of this study lies in the results. First, the results add to the literature of inequitable distribution of alcohol outlets in deprived areas, a result consistent with other studies (LaVeist and Wallace, 2000, Pollack et al., 2005, Romley et al., 2007). However, previous New Zealand researchers did not examine the distances and densities of alcohol outlets in different regions. Therefore, this is the first study to show inequitable spatial distribution in the 16 regions of New Zealand, thus showing that some regions have higher densities than others. Additionally, this study was conducted at a national level for both urban and rural areas and for the main alcohol outlets. Restaurants were excluded because most of them allow patrons to bring their own drinks. Therefore including restaurants could have led to double counting. Previous research in New Zealand examined only urban areas, single cities or else included restaurants (Hay et al., 2009, Pearce et al., 2008a).

Secondly, this thesis contributes to an improved understanding of the way effects of ‘place’ can be measured, by developing accurate and appropriately varied measures of access to alcohol outlets, adding to the existing literature. As mentioned in Chapter 1, there were some methodological limitations in previous studies (e.g.Pollack et al., 2005). Also, recognising that the influence of resources spreads beyond administrative boundaries, this study developed straight line Euclidean distance measures within buffers of 800 and 3000 metres.

10.3.3 Access to, and density of, alcohol outlets in relation to alcohol-related behaviour

Starting with access to outlets and alcohol-related behaviour, this study found that, at the national level, there was no association between either hazardous or frequent consumption of alcohol and access to alcohol outlets, a result consistent with studies conducted elsewhere (Pollack et al., 2005). However, after controlling for a range of potential confounding variables there was an association for particular groups. These included young Māori and Pacific Island people (aged 15-24 years) and older people aged 75 years and over. Both groups had higher odds of hazardous consumption when living closer to an alcohol outlet, a pattern not seen in other ethnic groups of similar ages. Younger European women aged 15–24 years living in neighbourhoods that had seven or more outlets within walking distance also had increased odds of hazardous alcohol consumption after controlling for individual characteristics and contextual variables, a result consistent with research from Louisiana (Schonlau et al., 2008).

There were also expected significant associations consistent with other population groups. For instance, for men aged 45–54 years, all Europeans (for all age groups), Māori and Pacific Island males, and rural females, the level of frequent consumption declined with increasing distance from liquor outlets. Similarly, for both Māori and Pacific Island males and females aged 25-34 years, European males and Māori and Pacific Island females aged 55-64, and rural males and females, the level of hazardous consumption and frequent consumption increased as the density of alcohol outlets increased within both the 800 and 3000 metre buffers. However, for some other groups, the results were not consistent with expectations. For instance, for men in rural areas, hazardous and frequent consumption increased as distance increased.

These finding contribute to existing research in five ways. First they indicate that a partial explanation of hazardous and frequent alcohol consumption lies in contextual factors and add to the growing body of literature that suggests that environments in which we live influence our health behaviour. The results were able to show that, after controlling for a range of confounders, ‘place’ measures influence both frequent and hazardous consumption independently. Importantly, the results indicate that ‘place’ (‘intoxigenic’ environments) influences only some sub-populations. This research is the first national study in New Zealand to report such associations, others having reported associations only in one city (Huckle et al., 2008).

Secondly, the study contributes to the literature by showing that access to alcohol outlets influences frequent and hazardous consumption for certain sub-populations, especially Māori/Pacific Island persons, even after controlling for deprivation. Since this study has identified Māori and Pacific Island people as the ethnic group most likely to be influenced by proximity to, and density of alcohol outlets, both community and individual based intervention strategies should be put in place. Importantly, other alcohol drinking behaviours were analysed (including frequent consumption) and showed that both density of, and proximity to, alcohol outlets were associated with behaviours that were precursors for hazardous consumption. Sixty-five percent of frequent consumers of five or more drinks were also hazardous consumers. One implication, therefore, is that community-based intervention programmes could be commenced early for frequent alcohol consumers before they develop into hazardous consumers. As was done with the AUDIT, where doctors carried out mandatory questioning about alcohol behaviour, similar frequent monitoring by doctors will help identify frequent consumers (Babor et al., 2001). Babor et al., (2001) contend that it is important to screen patients attending primary care for alcohol consumption. They argue that this provides an opportunity to advise the patients about moderate low risk consumption and the risks associated with excessive alcohol use. Moreover, screening will also allow the caregiver to know what contraindications may arise, if they know the frequency of consumption before prescribing medications. Most importantly, they argue that caregivers can take preventive measures which have proven effective in reducing alcohol related risk. The ALAC 2009-2012 strategy for Māori and Pacific Island people identifies research as a key component contributing to targeted interventions (ALAC, 2009), therefore this research has the potential to be a key informer of new knowledge for target interventions.

Thirdly, this study contributes to the literature by showing that local environmental and behavioural covariates strongly associated with alcohol were different spatially as was evidenced in differences between rural and urban areas. While most research has concentrated on urban areas, it is only in rural areas that some sub-populations were influenced by contextual factors. This study shows that rural areas are just as important as urban areas when examining contextual factors.

Fourthly, this study speculated on some of the reasons why some sub-populations have strong 'place' effects and highlighted different mechanisms influencing these. For example, the elderly people aged 75 and over are more likely to be less mobile and therefore use local resources. Similarly, Māori/Pacific Island females are more likely to be home makers and therefore constrained within their locality (Chapple, 2000). Such mechanisms are important in developing future theory linking people to 'place' and contribute to the literature linking higher densities of alcohol outlets to consumption. Most studies do not explain the link between 'place' and health behaviour, presumably because they are interested in just showing associations or they have not known the reason why there is a link. Therefore a strength of this study is that explanations of why ‘place’ is important for different sub-populations are postulated.

The final contribution of this study lies in methodological consideration and the data used. The NZHS (2006/07) was undertaken professionally using rigorous sampling techniques and therefore provides an accurate representation of alcohol-related behaviour. This survey provided a large data set and covered almost all the social, cultural and economic differences available in New Zealand. The survey highlighted different consumption patterns and identified geographical areas for different individuals. Using this information and having geo-coded alcohol outlets for all of New Zealand, a strength of this research lies in the use of accurate data for both outlets and for consumption.

10.3.4 Increased hospitalisation with an increase in alcohol outlets

Although the predicted explained variance in hospitalisation rates was lower than the variance explained by control variables, the density of alcohol outlets nevertheless predicted a significant portion, after controlling for a range of confounding variables. Similarly, despite both the type and category of alcohol outlet being significant, the explained variance in hospitalisation rates explained by both was low. Importantly, however, all alcohol outlets were significant and therefore higher densities of alcohol outlets by type and category have an association with hospitalisation.

Interestingly only one other study has examined the relationship between the density of alcohol outlets and hospitalisation (Tatlow et al., 2000). Therefore, this study contributes to the literature by showing that a higher density of alcohol outlets can result in an increase in alcohol related hospitalisation. An additional contribution was that increased densities of different types and categories of alcohol outlets also have an association with hospitalisation, therefore showing increased risk for hospitalisation for those exposed. The location of alcohol outlets is modifiable and policy makers can use the results of this study to design intervention strategies that can mitigate alcohol-related hospitalisation at a boarder structural level.

10.3.5 Increased crime with an increase in alcohol outlets

This study indicates that the density of alcohol outlets whether by type or category, predict both minor and serious violent crime occurring at different locations. The density of off-licenses was a predictor of minor violent crime occurring at dwellings while the density of on-licences predicted serious violent crime occurring at licensed premises. For minor violent crime occurring on roads, only bottle stores were significantly associated. Not surprisingly, for crime occurring at licensed premises, the density of on-licenses predicted a higher explained variance than the density of off-licenses for both minor and serious violent crime. Suffice to say that most of the explained variance in crime was predicted by the density of alcohol outlets.

Secondly, the results were further stratified by type and category of alcohol outlet, since there were theories that these stratifications have unique relationships with certain types of crime (e.g. off licenses were associated with increase in domestic violence, since alcohol was mostly consumed at home). While there are other international studies that have shown an association between different types and categories of outlets and certain crimes, (e.g.Gruenewald et al., 2006, Roman et al., 2008) this was the first study in New Zealand to examine the relationship between the density of types and categories of outlets and crime occurring in different places.

Thirdly, this is one of the first studies in New Zealand to examine the relationship between crime and alcohol outlets. This study provides research evidence to answer questions raised by the New Zealand Police, the Law Commission and the Ministry of Justice, all of whom are interested whether there is a relationship between outlets and crime given that they only had anecdotal evidence. Importantly, this study indicates that an increase in the density of alcohol outlets is associated with increases in crime. Therefore, a reduction in the number of outlets not only results in a reduction of excess alcohol consumption but also of alcohol-related outcomes, such as hospitalisation and crime.

10.4 Key methodological and theoretical contributions of this research to the analysis of 'place' effects

There has been a general lack of social theory linking 'place' and health outcomes. Macintyre et al., (1993; 2002) argue that research needs to focus more on explaining the links rather than describing social and health variations. Although this study focussed on access to alcohol outlets, it is important to provide a theoretical framework that links 'place' or contextual factors to health and how this research has contributed to the literature. This study found that hazardous consumption and the frequent consumption of five or more drinks on a regular basis had an association with the distance to, and the density of, alcohol outlets and adds to already existing literature on 'place'. This section first examines key methodological contributions and secondly, theoretical contributions are highlighted.

Starting with the former, the results from this study show that in New Zealand, there is an association between distance measures and the hazardous alcohol consumption of some sub-populations. This result is in contrast to other studies conducted elsewhere, which found no association between alcohol outlets and consumption (Makela et al., 2002, Pollack et al., 2005). A recent study in New Zealand however found significant relationship in Auckland, after using measures of 10 minutes of driving distance to alcohol outlets to delineate neighbourhoods (Huckle et al., 2008). 'Place' features are therefore an important influence in health after controlling for a range of confounders (Ross and Mirowsky, 2008). Most researchers have suggested that to be able to link health and 'place', studies must control for compositional factors that are known to influence health (Pickett and Pearl, 2001, Tunstall et al., 2004). This study controlled for age, gender, ethnicity, individual SES, individual deprivation, area deprivation and urban/rural location and still found significant 'place' influences.

This study adds to the theory that shorter distances to 'negative' resources influence health behaviour for some sectors of the population. Distance measures using population centroids as a starting point are important in the research on 'place' effects because they calculate the distance from homes as opposed to the centre of the meshblock as is the case with geometric centroids (Hay et al., 2009, Pearce et al., 2006). Different sub-populations had significant results based on whether the distance to alcohol outlets or density of alcohol outlets within the 800 and 3000 metre buffers were used. The home is the centre of purposeful activities outside of work, recreation, service needs, social networks and even physical activity (Lawton, 1977). Therefore, neighbourhood features around homes should be understood, particularly what they mean to individuals and how their lives are influenced by access to resources around them.

Alcohol researchers investigating ‘place’ are advised to engage with the density of the resources within the buffers, since most people’s neighbourhoods spread further than just one nearby resource. Buffers capture a wider neighbourhood, because resources have a significant influence over and above the administrative boundaries. While obesity and other health behaviour have used buffers to delineate geographical areas, this is less common in alcohol research. The choice of the distance used for buffers should consider the type of resource being examined; however, buffers of 800 metres and 3000 metres represent good choices for walking and driving distance (Donkin et al., 2000, Pasch et al., 2009, Pearce et al., 2008a). ‘Place’ research must consider how ‘negative’ resources influence some parts of population who live around them, using relevant-sized buffers rather than administrative boundaries. In addition, examining buffers is important because shopping for a few items could be done at the nearest general store/dairy while shopping for a larger number of items in a supermarket at a distance might be better when a car is used to carry the load.

Defining boundaries that are context-specific for different health behaviours is therefore important in ‘place’ research. Distance and buffer measures in this research were undertaken from the population-weighted centroid of a meshblock, the lowest geographical unit in New Zealand. Meshblocks were found to be an appropriate neighbourhood for only one sub-group, however buffers which captured a wider neighbourhood (800 metres and 3000 metres radius respectively), showed that many sub-populations might use resources not necessarily within the meshblock boundaries.

Linking the health surveys and ‘place’ measures through hierarchical modelling highlights the association where it exists, between the two. To this end, using data from surveys which are conducted nationally and have a rigorous sampling strategy may offer better explanations about health behaviour than using mortality and morbidity data alone, as both of these occur after the negative health behaviours have been in place for some time. Additionally, consideration must be taken of how unhealthy behaviour is measured. While measurements of heavy episodic or hazardous alcohol consumption and smoking rates (the number per day) are straight forward, this might not be the case for other health issues such as obesity, where current measures relate to people who are already obese. Although causality cannot be demonstrated in cross-sectional data, such analysis can help identify better intervention strategies.

Change in the distance to 'resources' can influence health either negatively or positively depending on the health behaviour being measured. In this study some sub-groups living in close proximity were more likely to consume hazardously. Townshend et al., (2009) also found access to be important for obesity research. Using a case study, they reported that in one area, when a boundary was created by building a wall, what was once a five minutes' walk to a convenience shop increased to 20 minutes because of a cul-de-sac. The immediate result was an increase in people driving to buy food. This shows that access is important and can directly influence health behaviour. The key point is that people tend to use resources that are within easy reach since they provide opportunities at a closer distance.

Methodological mechanisms linking 'place' to health behaviour notwithstanding, there are some theories also linking health behaviour of sub-populations directly to place. Access to a variety of resources modifies health in a somewhat complex way (Ellen et al., 2001). Some sub-populations are more responsive to access than others, depending on socio-economic status and age (Kobetz et al., 2003, McNeil ey al., 2006, Robert and Li, 2001). While the elderly and those in living in poorer areas were less mobile and therefore constrained within their locality (Glass and Balfour, 2003, Robert and Li, 2001), there were other groups that had strong identities that also encouraged the use of local resources (Lawton, 1977). This is because issues such as strong community identity and how people perceive their neighbourhoods are important in understanding why and how people use neighbourhood resources. The sub-populations most likely to be influenced by neighbourhood factors are minority ethnic groups, younger and older people, and those who are less affluent (Kobetz et al., 2003, McNeil ey al., 2006, Robert and Li, 2001). There are different mechanisms for each group. Since minority ethnic groups are more likely to live in deprived neighbourhoods, they are also most likely to be influenced by 'place' features since they are relatively poor and less mobile (Glass and Balfour, 2003, Robert and Li, 2001). Such areas may also have easier access to 'negative' resources in some countries, but not all.

While areas with many resources offer many opportunities, those without resources have reduced opportunities, but people adapt their behaviour to the available resources (Bernard et al., 2007). Women of minority ethnic groups have a more localised focus because of being home-makers reliant on welfare benefits, and thus they are more likely to use local resources as they are the most accessible (Barnett et al., 2004, Chapple, 2000). Older people are also more likely to rely on neighbourhood resources, because of their reduced mobility and, in some cases, strongly identifying with their neighbourhood (Robert and Li, 2001). Older people mentioned inaccessibility of services and lack of social contact as reason for wanting to move out of a neighbourhood (Brody, 1979, Carp and Carp, 1982). The relationship between sub-populations and 'place' is complex and context-specific depending on the type of health problem being examined. This study has highlighted some mechanisms that relate neighbourhood sub-populations to health.

Another mechanism linking health behaviour to 'place, is occupation and whether one owns a car or not. Men and women who are unemployed or homemakers are more likely to rely on neighbourhood resources. Similarly those without access to car will tend to rely on local resources especially if transport is not adequate. In welfare states, this scenario also applies to those are on welfare benefits (Chapple, 2000). A smoking study hypothesised that women who are home-makers were more likely to use resources available locally (Barnett et al., 2004). This is because they are 'locked' within their neighbourhoods. Those without cars or public transport are also 'locked' in their neighbourhoods. In rural areas particularly, where employment opportunities are rare, and distances to resources greater, most women would use local resources more than men. This was evident in this study where men's consumption increased with distance while womens consumption decreased. Occupation and car ownership is therefore a mechanism linking 'place' and health behaviour.

Research on 'negative resources' should be context-specific. While this research found that access to the nearest alcohol outlets had an effect on some sub-populations, such relationships might not be straightforward in relation to other health behaviours. What is difficult to disentangle is why, in some countries, some people choose unhealthy food over healthy food, and yet both may be located in close proximity. For example, in New

Zealand, there is no association between levels of obesity and access to fast food (Pearce et al., 2009a). Similarly, Scotland has one of the highest alcohol consumption rates in deprived areas, yet the association between alcohol outlet location and deprivation is mixed. There is no definite pattern within deprived areas (Ellaway et al., 2010). Ellaway et al., (2010) suggest that although they did not investigate the relationship between alcohol outlets and consumption directly, places with more outlets in deprived areas had higher rates of hospitalisation for alcohol-related diseases, compared to places where deprived areas had fewer outlets. As Macintyre et al., (2002) note, 'place' effects influence individuals differently even when similar areas have the same socio-economic status. Other researchers have suggested that there is a need to also examine price since research has shown that cheap food, high in calories, is more accessible in deprived neighbourhoods. Healthy food, meanwhile, may be more expensive in deprived neighbourhoods than it is in affluent neighbourhoods (Inagami et al., 2009). Price is therefore an important mechanism linking health behaviour to 'place'.

This research also contributes to the theory of gendered experience of place where different genders are more likely to be influenced by place differently depending on the outcome measure (Ellaway and Macintyre, 2009). Different sub-populations had significant associations and explanations varied. For example, while the difference between Māori and Pacific Island consumption was only 12%, males were more likely to be influenced by distance to alcohol outlets but not females. However, more female groups had an association with density of alcohol outlets. Similarly, in Scotland smoking was more prevalent amongst women who are suggested to develop smoking immediately after experiencing neighbourhood stress while for men there are time lags (Ellaway and Macintyre, 2009). Different genders therefore have different place experiences. Other writers have shown that while men were more likely to be influenced by resources that were in close proximity, women were more likely to choose from a wider variety of resources because they plan their activities according to their needs (Brodersen et al., 2005, Norman et al., 2006). Research must consider how different genders behave in certain places and determine the outcome. Therefore place research must examine both separately rather than lumping them together. As Macintyre and Ellaway (2003) suggest, *one size does not fit all* in place research, therefore theory must be developed separately for different groups. One recommendation therefore is to have direct distance access measures for men while having density measures for women.

There are other researchers who have suggested a need to examine complex transactional models that include neighbourhood processes and peer group processes, all interacting at the same time (Roosa et al., 2003). In the case of health behaviours, peer pressure of reciprocity means that when one buys alcohol or cigarettes today, it is your turn in the future. Because of peer pressure there is constant demand to keep on drinking or smoking (Watson et al., 1988). At the same time such peers could be residing in an area with many outlets or a higher density of alcohol outlets therefore presenting many opportunities to drink. Because of the many opportunities and peer pressure, such people are likely to drink hazardously, highlighting one mechanism that links place to individual behaviour, indicating that higher social capital can also be health damaging. Stead et al., (2001) also concur that higher social capital can be both health damaging and protective. Areas that have a strong community identity and networks can sometimes lead to clustering of behaviour (Pampalon et al., 2007). Stead et al., (2001) found that strong community identities and networks were related to smoking. Those with strong community identity might have worse health behaviour based on availability of resources around them providing opportunities.

There are also indirect impacts of alcohol outlet density on individual behaviour. Scribner et al., (2000) argue that alcohol outlets have a structural influence on norms and consumption patterns within the community, which explains individual consumption. Heavy drinking norms are formed in neighbourhoods with higher densities of alcohol outlets (Scribner et al., 2000). Other writers such as Paton (2001) and Ahern (2007) concur with Scribner. They argue that strong social networks within a community can either promote or inhibit drinking. While most researchers have associated obesity with access to a range of resources, smoking research on the other hand has been inconclusive on the importance of access. However, both obesity and smoking have been examined using other neighbourhood measures such as neighbourhood stresses of the physical and social environment, and neighbourhood based networks and norms.

This research was able to link ‘place’ to individual behaviour and explain some mechanisms linking the two. There are modifiable structures in the environments that are amenable to policy at a broader community and structural rather than at individual level. Hiscock et al., (2009) suggest that deprived areas are hard to reach especially with smoking cessation strategies therefore structural efforts in such areas maybe more effective than concentrating on individuals. Understanding the place effects that contribute to smoking, obesity and alcohol consumption are of paramount importance in prevention strategies. In conclusion, as Macintyre and Ellaway (2003) suggest there is no *a priori* reason to assume that all sub-populations will be influenced by neighbourhood factors. As was shown in the earlier analysis and also by obesity and smoking research, different sub-populations will be affected by neighbourhoods based on a number of varying reasons and the mechanisms linking them to health are also varied. Some people may be exposed and suffer ill health immediately while others may take a while, others influenced by distance, some by density. While the search is still on for a coherent theory, many factors have to be considered such as poverty level, occupation, gender, age, norms and cultural beliefs, for all different subgroups and as mentioned earlier, *one size does not fit all*. However, this research has highlighted some theories that are relevant for health behaviour.

10.5 Strategies to mitigate environmental factors that influence alcohol consumption

Babor et al., (2003) contend that alcohol consumption is multi-factorial and involves a complex interplay of individual consumption patterns with cultural, economic and physical environments, and also political and social contexts. Policies, therefore, need to be based on scientific evidence regarding a multiplicity of issues before changes are made to existing policies or new policies are proposed. Babor et al., (2003), Caswell and Thamarangsi (2009), and Popova et al., (2009) in their reviews suggest that alcohol consumption and related harm can only be reduced by controlling both prices and hours of operation, and also by reducing the density of alcohol outlets. Despite their suggestions, most evidence and policies in New Zealand have focussed on individual education, price increases, the prevention of under-age purchasing and attempts to prevent people becoming hazardous or frequent consumers. This study however, provides national evidence illustrating how ease of access to alcohol outlets influences alcohol-related behaviour and its subsequent impacts.

Many previous studies ignored the importance of alcohol outlets in excess consumption and other alcohol-related impacts, focussing instead on individual factors (Bierut et al., 1998, Rice et al., 1998). Since the 1990s, however, the focus on the prevention of alcohol-related harm has widened from individual and psychological characteristics to macro-level environmental factors such as availability of alcohol (Wagenaar and Perry, 1994, Perry et al., 1993). This study has shown that there is an association between 'place' and both hazardous and frequent consumption on some sub-populations and alcohol-related impacts, such as hospitalisation and crime, over and above individual factors. Policies therefore need to examine environmental factors related to alcohol availability since the reduction of consumption and alcohol-related harm is of interest to the wider public health.

> "It's important to understand and compare state policies around alcohol because the impact of alcohol use is profound" (Alexander Wagenaar, 2007 p 1).

This quotation emphasises the importance of examining current alcohol policies in New Zealand and elsewhere. The following section aims to discuss current policies that regulate alcohol consumption in New Zealand and suggest some environmental interventions that might be relevant, using examples from successful interventions worldwide. Gruenewald et al., (2007) argue that alcohol-related harm is now well understood because of developments in statistical and geographical analysis. Furthermore, such harm is moderated by 'place' characteristics and "may be amendable to local policy action" (Hill, 2004). Based on the summarised results in the first section of this chapter, the next section begins by briefly examining policy in New Zealand and then makes some recommendations for interventions and policy changes.

10.5.1 Alcohol policy

Alcohol policies differ from country to country. However, they mostly have the same structure with the central government setting the rules and the local government enforcing them. In the USA, the density of alcohol outlets is managed and controlled by the state governments. However, at times under state jurisdiction, local governments may regulate outlets by enforcing licensing and zoning rules. Similar policies exist in New Zealand where central government creates licensing regulations and local governments implement and enforce them. Historical changes from when people used to vote for control, and changes over time including conscience votes, have been highlighted in two New Zealand documents by Stewart and Casswell (1992), and the Law Commission (2009) chaired by Sir Geoffrey Palmer. Both documents suggest that the conscience vote has made any alcohol legislation very difficult to enact, because the Members of Parliament cannot be 'whipped' into a common position. Despite the conscience vote and the difficulty in amending alcohol laws, there are three Acts that are suggested to have either contributed to increased consumption and availability in New Zealand or failed to recognise the importance of environmental factors. These are the Resource Management Act (RMA), 1991, the Sale of Liquor Act (1989) which introduced wine and later beer into the local supermarkets and the Local Government Act (LGA) 2002.

10.5.2 Resource Management Act 1991

The purpose of the RMA (1991) is to promote the sustainable management of natural and physical resources. Section Two of the Act states that, sustainable management means managing the use, development and protection of natural and physical resources in a way or at a rate that enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety. Most commentators have suggested that the Act is not very specific because while urban planning and development received less attention, there are no clear guidelines. However, the Act completely ignores health and safety with the result being that business can be established in any area without considering such issues (Perkins and Thorns, 2001). Hill (2004) adds that the RMA is a planning instrument for districts, and without clear guidelines, except zoning to regulate land use for residential, business and other activities; such zoning might result in alcohol outlets locating in certain areas. Designated commercial zoned areas are probably the reason why there are more outlets located in some areas, however, the Liquor Licensing Act (1989) increased the number of outlets that could sell alcohol in outlets that previously did not retail.

10.5.3 Liquor Licensing Act 1989

In New Zealand prior to 1989, new liquor licenses were granted based on whether the community needed one and this was in relation to the total population of an area.

However, in 1989, the Sale of Liquor Act was enacted and the condition for granting licenses changed. Following the Act, licences were now granted based on whether a person was suitable for establishing an outlet and met the planning criteria. One consequence was a proliferation of licenses in the 1990s because of an expansion in the range of places where alcohol could be sold (Stewart and Casswell, 1992). It was also in 1989 that supermarkets were permitted to sell wine. A 1999 amendment to the Act, allowed supermarkets to also sell beer, completely liberalising the sale of alcohol (Kypri, 2003). Hill (2004) adds that not only did the 1989 Act increase access to alcohol since most supermarkets are in residential areas, but it also increased the availability of alcohol by increasing trading hours, including allowing 24 hour licences which hitherto had not been allowed. By December 1999, trading was allowed seven days a week for all licenses. Lowering the minimum age for the purchase of alcohol to 18 by a 1999 amendment to the Act resulted in increase in drinking by young people aged 15-17, who are not legally allowed to purchase alcohol (Hill, 2004).

According to Hill, (2004) the Sale of Liquor Act, (1989), focussed on the management of licensed premises. Furthermore, the Act advocated for more community control with the Act specifying that the location and type of outlet should be suitable for the residents of the location where the outlets were to be located. The community therefore could object to an outlet. However, there had to be sufficient evidence of harm for the local authority to act. This, therefore, meant that any applicant could place an advertisement in the newspaper stating the street address of the intended outlets. Members of the community could object by writing to the licensing board, with concrete evidence of harm, which was mostly lacking despite many outlets being concentrated in particular areas. Hill (2004) suggested that liquor licensing was subject to different interpretations, making it difficult for communities to demonstrate any adverse effects without scientific evidence. Hill (2004) further adds that in the 1990s the liquor licensing authorities complained to Parliament that most traders were taking advantage of poor legislation and that the authorities were powerless. This was corrected by amendments to the Act in 2003 when district licensing authorities were given more power to license liquor stores based on the criteria that suited the licensing board. However, even with increased powers, the licensing authority could not effect change if there was an already existing land use right that predated the plans. In the United States, the City of Los Angeles local government changed land use rights to reduce harm after the infamous riots of 1992, when white policemen accused of brutally assaulting African-American Rodney King were acquitted. New bylaws were created that prevented the re-opening of liquor outlets that had been closed following the riots (Ashe et al., 2003). Therefore it is important to examine the New Zealand Local Government Act.

10.5.4 Local Government Act (2002)

Amongst many aims, the Local Government Act 2002 (LGA) is intended to support local authorities playing a broad role in promoting the social, economic, environmental, and cultural well-being of their communities, taking a sustainable development approach. The LGA, however, is silent on how the environment contributes to unhealthy behaviour and ill health, thereby ignoring the basic fundamental right of environments that are free from disease (Davis and Kelly 1993) . The LGA was enacted so that TAs could take on greater social responsibility, so some mention of this is necessary. The local authorities were responsible for all environmental issues including water, air and sanitation quality. For instance, local government must supply clean water services to everyone. Despite such noble undertaking of protecting and using the environment in a sustainable manner, a major omission of the LGA was a consideration of the effect of environment on health. First, the definition of environment was narrow and was geared towards natural resources. Secondly, the Act did not consider other environmental features such as access to 'negative' resources and their influence on health. Of most significance, despite studies showing how environment can influence health and contribute to inequality, such factors are completely ignored by the LGA. In summary, despite an increased focus on social issues, the LGA ignored the issues of how the environment that people live in influences their health, yet the LGA empowers local authorities to create by-laws that are suitable for them. Hill (2004) suggest that even the 'Precautionary Principle', Principle 15 of Rio Declaration 1992 gives local governments or decision makers the responsibility to protect human and environmental health, despite lack of scientific evidence in some cases. This means talking anticipatory action to reduce or alleviate alcohol-related harm.

This section has examined the three Acts and highlighted some gaps and barriers. While the Liquor Licensing Act has no action on social and public health impacts, the LGA can. Similarly the RMA can be manipulated to suit businesses, however once by-laws are created by LGA, the rules might be enforced or better interpreted. Importantly, while alcohol related harm is a problem in different areas, the three Acts have not done much to deter adverse social impacts. However, communities can decrease local alcohol-related harm by engaging with urban planners and changing licensing policies that increases local alcohol availability. The next section therefore examines policies in other countries and suggests future ideas on reducing alcohol related harm especially those caused by ‘place’.

10.6 Strategies for interventions and policies

There are many studies that have been used as evidence in developing strategies in different countries to reduce alcohol consumption. Based on the evidence from this study, three strategies used elsewhere will be highlighted. These are, the use of zoning ordinances, reducing the number of alcohol outlets and increases in taxation on alcohol, thus raising prices.

10.6.1 Zoning Ordinances

In the USA, a common strategy has been to use zoning ordinances. Zoning ordinances can use Conditional Use Permits (CUP) to set the conditions that alcohol outlets operate under and also where they can be located (Wagenaar, 2007). The CUP provides communities and local governments with the opportunity to regulate outlet numbers and locations as well as their trading hours. CUPs have been successfully used in California where Wagenaar (2007) reports that localities with robust CUPs have benefitted, since all applicants are screened and members of the community participate in debating on the pros and cons of establishing any additional outlets. Wagenaar (2007) suggests that with CUPs, communities can control the number of outlets and prevent the massing of alcohol outlets in any one area, both now and in the future. Wageneer (2007) gives an example of a CUP in action in California. A community opposed the location of an outlet in a new development and instead asked the owner to build a day-care centre, which they felt was more beneficial to the community, as there were many alcohol outlets already located in the area (Wagenaar, 2007). The centre was successful because the city provided the finances while the community patronised the day care centre. This shows that whatever is suggested by the community can be successful. The CUP could be used in areas with the highest burden of alcohol-related harm. Studies have shown that a total alcohol ban in certain identified communities results in a reduction of harm (Bowerman, 1997, Britt et al., 2005, Escobedo and Ortiz, 2002, Parker et al., 1978). Sewel (2002) argues that policies that target certain people in certain areas maybe more effective than policies that target everyone, since the latter affects all drinkers including moderate consumers.

10.6.2 Reducing the number of outlets

A second strategy, often used in conjunction with zoning, is to reduce the number of alcohol outlets in areas with significantly higher densities. Babor et al., (2003) argue that availability of alcohol either through commercial or social sources increases alcohol-related harm. Studies in Canada have indicated significant relationships between reductions in alcohol consumption and a decrease in the density of off-licences (Xie et al., 2000). Moreover, it is suggested that a higher density of alcohol outlets can alter the social norms around outlets, leading to violent crime (Campbell et al., 2009). Campbell et al., (2009), in their review suggest that a reduction in number of alcohol outlets will reduce consumption and other related health and social outcomes. Gruenewald et al., (2006) reported that in California, reducing the number of bars by just one (in a Zip Code area) would result in 290 fewer crimes. One strategy recommended, therefore, would be to reduce the number of outlets in deprived areas (Grills et al., 1996). Four effects are anticipated from such an action. First, distances to outlets would be increased, effectively increasing alcohol prices with people having to pay for the cost of the extra travel to get their alcohol. Secondly, with alcohol outlets dispersed out, the social norms around drinking may change and result in a reduction of consumption (Campbell et al., 2009). Thirdly, a decrease in the number of outlets may result in a decrease in the number of people congregating in and around off-licences with an associated reduction in crime and/or aggressive behaviour. Studies have shown that dramatic events (e.g. civil unrest in Los Angeles) and natural disasters (e.g.an earthquake) that resulted in a decrease in alcohol outlets led to a significant decrease in alcohol-related harm (Cohen et al., 2006, Shimizu et al., 2000). Fourthly, restricted hours of operation, reduced access to retail outlets and limiting the number of outlets has resulted in decreased alcohol related consumption and harm (Gruenewald, 2007, Livingston et al., 2007, Room et al., 2002, Stockwell and Chikritzhs, 2009).

However, there are key problems with this strategy. First, most studies examining decreases in the number of outlets have mostly used evidence from dramatic events such as the riots in Los Angeles or natural disasters. Therefore little scientific evidence is available on whether such changes are plausible. Additionally, other policy changes may also be enforced as the same time, therefore isolating the effects of alcohol outlets change may be difficult (Campbell et al., 2009). Secondly, the effect of reducing outlets on alcohol behaviour may be gradual and may only affect some sub-populations and not everyone (Campbell et al., 2009, Livingston et al., 2007).

10.6.3 Increase in taxation

A reduction in density of alcohol outlets could be used in conjunction with increases in price. Suffice to note that despite the presence of alcohol outlets, it is the ability of people to purchase or obtain alcohol that result in excess consumption. Livingston et al., (2007) argue that with the bunching of outlets in certain areas, alcohol outlet owners in such areas try to maintain a niche in the market by reducing their prices or having promotions. The result is a significant reduction in alcohol price. However, there is evidence that higher alcohol prices are a deterrent to excess consumption and other social and health outcomes (Elder et al., 2010). For example, a number of studies have shown an inverse relationship between price and general consumption (Rush et al., 1986, Gray et al., 1999, Ornstein and Hanssens, 1985, Hoadley et al., 1982, Beard et al., 1997, Ruhm, 1995, Kuo et al., 2003), adolescent consumption (Grossman et al., 1993, Laixuthai and Chaloupka, 1993, Coate and Grossman, 1988, Pacula, 1998, Kenkel, 1993, Cook and Moore, 1994), non-motor vehicle mortality (Cook, 1981, Selvenathan, 1988, Sloan et al., 1994, Cook and Tauchen, 1982, Heien and Pompelli, 1997) and violence (Markowitz and Grossman, 1998, Markowitz and Grossman, 2000). The implication therefore, is that places with fewer outlets have higher prices as there would be no need for promotions as was found in Denmark and Sweden (Norstrom, 2001). The price of alcohol increased as distance to alcohol outlet increased similar to 'retail gravity models'.

One recommendation could be to increase alcohol prices and make them uniform everywhere. Studies have shown that an increase in the price of alcohol, especially at liquor stores and supermarkets, might reduce individual's purchasing power and consequently lower alcohol consumption. Research from the UK has consistently shown that alcohol from supermarkets and other off-licences are lower priced and often sold below cost (Meier, 2008), which exacerbates the drinking problem, especially in countries where such outlets are mostly located in less affluent areas.

Policies should be enacted that discourage discounts and lower prices for alcohol in supermarkets, where there is currently no limit on the amount that one can buy. Elder et al., (2010) suggest price has a big influence on those without much disposable income, such as the underage drinker. Elder et al., (2010) argue in their review that no study has examined the association between either age or income and price increases and alcohol consumption. Importantly, there is evidence from other countries has shown that increase in prices is a policy that has the potential of succeeding.

10.6.4 Recommendations

Based on the three strategies reviewed, the same strategies are recommended for use in New Zealand. One unique addition to the three strategies is the local government penalty ordinances. These recommendations should first be pilot tested in small areas (such as a CAU), and if found to be successful then expanded to larger geographical areas (such as TAs). This kind of testing on small areas is important, because this study examined only one aspect of neighbourhoods and there is a recognition that other factors may be at work. In addition, as mentioned in Section 9.4.1, some of the results presented here may be because of multiple testing or chance.

Local authorities could use CUPs to control or zone the number of outlets, with the community having the right to oppose the location of a new outlet when one closes down. CUPs, therefore, would enable communities to participate in decision making, compared to the current policy where an applicant places an advertisement in the newspaper and people are supposed to present their objections within 10 days. CUPs could be an important tool for New Zealand since this study has shown that poorer areas have a greater density of, and better access to, alcohol outlets. CUPs would enable community participation to be more robust as well as giving local authorities more control. With CUPs, members of the community interview prospective alcohol outlet owners before a business is set up. Community involvement would ensure that a new outlet would be compatible with their neighbourhood in terms of noise levels and opening hours. Members of the community would, therefore, need to be aware of licensing laws. Towards this end, strong community education would be encouraged especially for those in low SES areas who are probably less educated than their high SES counterparts. Mixing both individual and structural interventions is therefore paramount. The same zoning laws and land prices that keep liquor outlets and high risk businesses away from wealthy neighbourhoods could be applied in deprived neighbourhoods. In New Zealand, such zoning practices could be adopted and applied to existing land use rights. One of the issues highlighted by Hill (2004) was that despite the local authorities having more powers to regulate outlets, they could not change an existing land use right, therefore if an alcohol outlet was closed, it would be replaced by another one in the same location.

This research has highlighted that zoning of alcohol outlets should mostly be in deprived areas, where alcohol outlets are concentrated. Places with a higher proportion of Māori and Pacific Island people have elevated levels of alcohol consumption and crime, therefore such areas (with higher proportions of Māori and Pacific Island people) could be zoned first. This is important so that moderate consumers are not inconvenienced, with the increased distance. First and foremost, areas with a large proportion of people who are hazardous consumers or with the potential to be hazardous consumers should be targeted. However, more analysis needs to be undertaken to identify specific geographic areas before deciding on which areas are the most affected and, therefore, should be targeted. This research was not able to undertake further analysis by specific geographical locations such as DHBs, TLAs, or CAUs because of existing confidentiality issues, yet the NZHS 2006/07 showed that hazardous consumption varies by location. For targeted interventions, such analysis is necessary. Further spatial analysis of the data without strict confidentiality would shed more light on which specific cities or locations to target first.

A second proposed strategy, going hand in hand with zoning, is to reduce the density of alcohol outlets. This study has shown that alcohol outlet density influences both hazardous and frequent consumption and subsequent health and social outcomes. For example, the density of alcohol outlets has an association with both minor and serious violent crime, and alcohol-related hospitalisation is higher in areas with many alcohol outlets. On a cautionary note, however, issues of confidentiality made it difficult for this study to pinpoint either the level of outlet reductions or where to effectively reduce consumption, but deprived areas with minority ethnic groups, and many alcohol outlets could be a target. Recommendations include revoking licenses of convenience stores especially as was recently reported that most of them sell only alcohol, thus making more profits from alcohol than general stores/dairies (Greenhill, 2010). General stores/dairies should make more money from groceries than from alcohol or else be closed. Additionally, when an outlet closes in an area with many alcohol outlets, the land use rights could be changed so that it could be converted to another business which is useful for the community.

The third proposed strategy is to enact regulations that deter discounting in both on- and off-license premises. Casswell et al., (2005) state that New Zealand compares poorly to other OECD countries as alcohol taxes are 10% lower. Prices could be set at a fixed amount for all the licences in order to discourage promotions and excessive consumption. In other words, there could be prohibition on discounted alcohol prices that are lower than standard prices in the community (Wagenaar, 2007). While proximity is a very important factor, the effect of pricing cannot be overlooked. Alcohol availability is influenced not only by ease of access but also affordability. People of lower SES, are more responsive to cheap alcohol, yet alcohol sold in on-licenses is three or four times more expensive than in off-licenses. Most people therefore preload from off-licenses (Withrington, 2007), such as supermarkets and grocery stores (Meier, 2008). Such relatively cheap alcohol is associated with excess consumption since there is no restriction on the amount of alcohol that can be purchased (Tahana, 2008).

A final recommended strategy is that the LGA could be amended to engage with environment and health. The local government could be advised to use results of this study and other studies that have evidence of health inequality exacerbated by contextual factors. Access to ‘negative resources’ are environmental issues that are health damaging. Just like there are consequences for violating terms of water and sewage usage, such by-laws could be enacted to reduce harm caused by ease of access to ‘negative’ resources, and the larger environment. The LGA can be used to create bylaws that would enforce closing down alcohol outlets for violations. For instance, outlawing outlets and revoking licenses of outlets in areas with high rates of violence and increased hazardous consumption. All people reporting crime occurring at outlets could be asked for name and location. Additionally, using by-laws to change existing land use rights from alcohol outlets to retail shops or offices as was undertaken in the USA (Ashe et al., 2003). As mentioned earlier, the LGA will strengthen the Liquor Licensing Act and the RMA by creating by-laws that could be adhered to before licenses are renewed or given. One advantage of by-laws is that it can be anticipatory to future problems, as opposed to legislation which require scientific evidence. The LGA is therefore one way of creating and enforcing new rules. As Wagenaar (2007) recommends, the court processes are sometimes lengthy therefore an administrative penalty ordinance allows local governments to create and enforce standards of behaviour among alcohol outlets within their jurisdictions.

10.7 Future research

While this research focussed on access to alcohol outlets, there are four key areas that should be prioritised to further knowledge in 'place' and alcohol research and they are listed in order.

First, future studies should use a mixture of both qualitative and quantitative methods, to better understand where alcohol is purchased, where consumption takes place, and to examine if outlets within neighbourhoods are actually the source of the alcohol drunk locally. While this study showed that odds for hazardous and frequent consumption were higher in areas with better access, research needs to further explore this relationship. This study did not examine actual purchases within the said establishments. Such research will also shed more light on mechanisms linking 'place' and alcohol consumption and whether such mechanisms differ for certain sub-populations. Similarly, researchers need to investigate what attracts people to certain locations or neighbourhoods selling alcohol, even when those locations are prone to crime. Such qualitative analysis will elucidate why crime occurs around outlets, particularly whether people target those who are drunk or whether it occurs simply because the outlets bring the offender and the victim together in one location. Such information would thus contribute to the theory linking alcohol outlet density to alcohol consumption and alcohol-related impacts.

Secondly, there are other neighbourhood mechanisms that were not tested in this study yet they are important. As mentioned in Chapter 3, there are some contextual factors such as social capital and cohesion, neighbourhood culture and norms that are central to understanding alcohol consumption patterns. A recommendation for future research is the need to develop additional measures of contextual or environmental factors such as social capital and cohesion. Research on alcohol consumption in New Zealand has rarely engaged with the social capital and cohesion, culture and social norms, yet there is evidence internationally that they influence health behaviour. Issues surrounding drinking cultures and social norms around outlets are imperative and could be a priority for future research. A further recommendation is the use of qualitative research to investigate drinking norms and cultures of people living in areas with many alcohol outlets. Such research will shed more light in further understanding the relationship between proximity to alcohol outlets and the norms and cultures surrounding them.

Thirdly, while qualitative research will shed more light on the processes involving consumption including norms around alcohol outlets, ultimately longitudinal studies will be needed to examine increases (or decreases) in alcohol outlets and the impact of such changes on consumption patterns of different sub-populations. This is important, especially in light of the increasing number of convenience stores that now sell alcoholic beverages. Additionally, few studies have investigated policy changes that reduce the number of alcohol outlets. Longitudinal studies can therefore be used to examine policies such as zoning or changes in the number of alcohol outlets to examine whether there are significant changes in hazardous consumption over time. Importantly, given that health related behaviour such as cigarette smoking is currently part of the New Zealand census, questions on alcohol consumption could also be included in future censuses. This would ensure that longitudinal comparisons could take place, just as has been carried out for smoking.

Fourthly, while the results presented are important at a national level, the results in Chapter 6 showed that access differed in specific geographic locations such as regions; therefore, further analysis is needed to identify whether people living in certain regions have different consumption patterns. Future research could investigate spatial differences in the regions. This would only be possible with the relaxing of the current stringent confidentiality requirements of the Ministry of Health ethics committee, where currently few variables can be used in analysis, on the condition that the researcher can avoid identifying individuals and areas where hazardous consumption occurs. Importantly, such an analysis would aid in identifying ‘hot spots’ as well as being able to calculate how many outlets need to be closed in order for consumption to reduce significantly as this is not uniform across all deprived areas. Suffice it to say that a reduction in outlets in Los Angeles (USA) and Great Hanshin (Japan) by dramatic events and natural disaster respectively resulted in a significant decrease in alcohol-related harm (Cohen et al., 2006, Shimizu et al., 2000). For effective intervention, analysis must be undertaken to identify the areas where the alcohol-related burden is high.

While these four areas are seen as key priorities there are also other future research ideas. There is need for determination of an appropriate distance to alcohol outlets, especially the threshold for easier access (Pasch et al., 2009) so that measures can be replicated worldwide. This research highlighted that young Māori and Pacific Island people who live in areas with easier access to alcohol outlets have higher odds of hazardous consumption. More research should be undertaken for similar age and ethnic groups who live in similar areas and are not hazardous consumers. Further studies also need to examine areas with many and easier access to alcohol outlets coupled with a significant number of young Māori and Pacific Island people, compared to areas with many alcohol outlets and fewer young Māori and Pacific Island people. Areas with many outlets and those with none, also need to be compared to further examine how access to alcohol outlets affects different sub-populations living in such areas.

Future research must also incorporate the length of time one may have lived in the neighbourhood, the migration status of those living there (Campo, 2002), and also the length of time before the environment is associated with disease (Blakely and Woodward, 2000), or perhaps how long it takes before an environment shapes one's behaviour, as these are all important in understanding the importance of geography in health research.

Moreover, more studies need to be done in rural areas to understand the reasons for the increase in alcohol-related male mortality and the decline in alcohol-related hospitalisation, instead of concentrating on reasons for increases in urban areas. Furthermore, while rural areas have relatively fewer outlets, the results indicate both positive and negative associations between alcohol consumption and the distance to, and the density of outlets for rural males and females. Researchers need to investigate these phenomena in rural areas, especially whether the increase in mortality is related to high consumption influenced by geography. Future studies need to examine policies of the alcohol industry, especially regarding changes where drinks are targeted toward young people and women. The alcohol industry is the main driver toward cheap and promotional alcohol.

10.8 Concluding remarks

This chapter has highlighted that this thesis provides new knowledge and contributes to the extant literature on place effects on health. Environmental factors play an important role in explaining the link between proximity to alcohol outlets and alcohol-related behaviour and its social impacts. Holloway et al., (2008), and Kneale and French (2008) have emphasised the importance of understanding places where problem drinkers and drinking are produced , in other words understanding 'intoxigenic' environments. While this study examined only one aspect of the environment, there were some sub-populations where exposure to 'intoxigenic' environments influenced their consumption. Increased inequality found when examining alcohol related mortality and hospitalisation could be as a result of 'place' effects that influences certain sub-groups and not others. While most studies, in the obesity and smoking literature, have found that women were more influenced by environmental factors, it is not a surprise that in alcohol consumption more sub-groups of males had significant results than did women. High consumption of alcohol has been a common characteristic amongst men for a long time.

Attempts to explain the link between both easier access to, and a higher density of, alcohol outlets and alcohol consumption revealed that it is important to understand the interplay between individual, social environmental and economic forces, since neighbourhoods are nested within local areas that are themselves nested within cities, regions or states and influenced by the employment and educational opportunities available in such neighbourhoods. Moreover neighbourhoods are also shaped by historical and cultural issues and patterns of migration. Each and every neighbourhood is therefore unique in its own way.

This study has gone some way to 'prove' the hypothesis that both access and proximity to alcohol outlets (intoxigenic environments), may offer a potential explanation about the links between neighbourhood deprivation, individuals' alcohol consumption, and health and social outcomes. These results indicate that alcohol-related behaviour and social outcomes, explained partly by proximity to alcohol outlets, provide evidence of social polarisation in New Zealand between groups of differing socio-economic status. Borrowing from Macdonald et al., (2007) our understanding has grown about ‘intoxigenic environments that contribute to excess alcohol consumption in New Zealand. This study offers further confirmation of spatial sorting of ‘intoxigenic’ environments especially in the most deprived areas, thus offering some explanations of spatial variations in alcohol consumption across different areas in New Zealand. This thesis adds to the growing evidence of ‘place’ effects on health and demonstrates that targeting individuals with alcohol messages will solve only part of the problem and reaches only a select few. Interventions should be targeted at ‘intoxigenic’ environments that lead individuals to have unhealthy behaviours. To create more awareness and reduce alcohol-related harm, public health officials, geographers, local government, police, the Ministry of Justice and city planners, must combine forces to create long term plans and policies to reduce ‘intoxigenic’ environments since the causes of excess alcohol consumption are multi-factorial and require expertise from multiple disciplines. Lastly, geographers must reflect on the theoretical basis upon which future alcohol research unfolds, since both individual and environmental determinants are important in understanding alcohol consumption.

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Appendices

Appendix 1: Confidence interval for Age-specific standardised rates of alcohol-related hospitalisations for males in New Zealand

Age group	Year of diagnosis							
	1999	2000	2001	2002	2003	2004	2005	2006
0-14	**3.68**	**5.13**	**4.13**	**4.21**	**3.78**	**2.78**	**2.83**	**2.81**
LCI	2.88	4.18	3.28	3.35	2.98	2.10	2.15	2.12
UCI	4.62	6.22	5.12	5.21	4.73	3.61	3.67	3.66
15-24	**43.34**	**52.52**	**55.85**	**51.04**	**48.06**	**47.37**	**54.64**	**61.71**
LCI	40.49	49.37	52.62	48.01	45.17	44.54	51.61	58.42
UCI	46.34	55.82	59.23	54.22	51.08	50.34	57.80	65.14
25-34	**41.30**	**46.00**	**48.22**	**45.09**	**44.42**	**45.86**	**46.96**	**46.48**
LCI	38.51	43.02	45.14	42.10	41.47	42.86	43.91	43.35
UCI	44.25	49.13	51.47	48.23	47.54	49.02	50.16	49.77
35-44	**38.34**	**42.82**	**40.99**	**42.97**	**39.54**	**40.31**	**44.56**	**47.46**
LCI	35.59	39.92	38.15	40.07	36.79	37.54	41.65	44.40
UCI	41.24	45.88	43.98	46.01	42.45	43.23	47.62	50.67
45-54	**37.48**	**36.34**	**37.09**	**37.09**	**35.62**	**33.51**	**35.06**	**39.65**
LCI	34.74	33.67	34.42	34.44	33.04	31.04	32.56	36.97
UCI	40.38	39.16	39.92	39.89	38.33	36.12	37.70	42.48
55-64	**33.50**	**31.30**	**28.33**	**27.80**	**28.77**	**26.33**	**25.95**	**29.40**
LCI	30.88	28.81	26.01	25.56	26.54	24.24	23.91	27.21
UCI	36.28	33.95	30.81	30.20	31.14	28.56	28.12	31.72
65+	**64.06**	**57.27**	**53.31**	**49.92**	**48.04**	**45.90**	**44.01**	**47.31**
LCI	60.22	53.67	49.87	46.62	44.84	42.80	41.02	44.21
UCI	68.09	61.05	56.93	53.39	51.41	49.15	47.15	50.56

Appendix 2: Confidence intervals for age specific standardised rates of alcohol-related hospitalisation for females in New Zealand

Age group	Year of diagnosis							
	1999	2000	2001	2002	2003	2004	2005	2006
0-14	**3.40**	**6.16**	**5.89**	**5.79**	**3.87**	**3.18**	**4.03**	**4.45**
LCI	2.62	5.09	4.85	4.76	3.04	2.43	3.18	3.54
UCI	4.34	7.38	7.09	6.98	4.86	4.09	5.03	5.51
15-24	**20.68**	**26.48**	**29.83**	**31.40**	**30.28**	**30.17**	**32.68**	**38.07**
LCI	18.71	24.24	27.46	29.00	27.97	27.88	30.32	35.47
UCI	22.81	28.88	32.35	33.94	32.73	32.58	35.17	40.80
25-34	**20.15**	**22.81**	**23.12**	**22.36**	**23.65**	**21.31**	**22.57**	**24.69**
LCI	18.27	20.80	21.07	20.35	21.58	19.35	20.55	22.52
UCI	22.17	24.97	25.31	24.52	25.86	23.41	24.74	27.01
35-44	**22.26**	**23.81**	**25.46**	**26.79**	**25.54**	**26.07**	**27.73**	**30.93**
LCI	20.22	21.70	23.30	24.59	23.41	23.92	25.53	28.57
UCI	24.45	26.06	27.78	29.15	27.82	28.35	30.08	33.42
45-54	**14.22**	**15.73**	**16.79**	**15.88**	**18.36**	**17.73**	**18.67**	**20.93**
LCI	12.56	14.00	15.02	14.18	16.55	15.98	16.89	19.04
UCI	16.04	17.61	18.70	17.72	20.31	19.63	20.58	22.97
55-64	**8.45**	**8.80**	**9.44**	**8.54**	**9.93**	**9.28**	**10.65**	**10.06**
LCI	7.17	7.51	8.13	7.33	8.65	8.06	9.37	8.81
UCI	9.89	10.24	10.90	9.89	11.35	10.62	12.06	11.44
65+	**15.69**	**12.13**	**13.54**	**11.40**	**11.70**	**11.64**	**10.10**	**12.56**
LCI	14.04	10.69	12.03	10.02	10.31	10.27	8.84	11.15
UCI	17.48	13.70	15.19	12.91	13.22	13.14	11.49	14.10

Appendix 3: Summary of Age standardised rates in alcohol hospitalisation, ratios and percentage increase

0-14 yrs	Male	Female	Ratio: Male: Female	45-54yrs	Male	Female	Ratio: Male: Female
1999	3.68	3.40	1.08	1999	37.48	14.22	2.64
2000	5.13	6.16	0.83	2000	36.34	15.73	2.31
2001	4.13	5.89	0.70	2001	37.09	16.79	2.21
2002	4.21	5.79	0.73	2002	37.09	15.88	2.34
2003	3.78	3.87	0.98	2003	35.62	18.36	1.94
2004	2.78	3.18	0.87	2004	33.51	17.73	1.89
2005	2.83	4.03	0.70	2005	35.06	18.67	1.88
2006	2.81	4.45	0.63	2006	39.65	20.93	1.89
%increase '99-'06	**-23.64**	**30.88**		**%increase '99-'06**	**5.79**	**47.19**	
15-24yrs	**Male**	**Female**	**Ratio: Male: Female**	**55-64yrs**	**Male**	**Female**	**Ratio: Male: Female**
1999	43.34	20.68	2.10	1999	33.50	8.45	3.96
2000	52.52	26.48	1.98	2000	31.30	8.80	3.56
2001	55.85	29.83	1.87	2001	28.33	9.44	3.00
2002	51.04	31.40	1.63	2002	27.80	8.54	3.26
2003	48.06	30.28	1.59	2003	28.77	9.93	2.90
2004	47.37	30.17	1.57	2004	26.33	9.28	2.84
2005	54.64	32.68	1.67	2005	25.95	10.65	2.44
2006	61.71	38.07	1.62	2006	29.40	10.06	2.92
% increase '99-'06	**42.39**	**84.09**		**%increase '99-'06**	**-12.24**	**19.05**	
25-34yrs	**Male**	**Female**	**Ratio: Male: Female**	**65+yrs**	**Male**	**Female**	**Ratio: Male: Female**
1999	41.30	20.15	2.05	1999	64.06	15.69	4.08
2000	46.00	22.81	2.02	2000	57.27	12.13	4.72
2001	48.22	23.12	2.09	2001	53.31	13.54	3.94
2002	45.09	22.36	2.02	2002	49.92	11.40	4.38
2003	44.42	23.65	1.88	2003	48.04	11.70	4.11
2004	45.86	21.31	2.15	2004	45.90	11.64	3.94
2005	46.96	22.57	2.08	2005	44.01	10.10	4.36
2006	46.48	24.69	1.88	2006	47.31	12.56	3.77
%increase '99-'06	**12.54**	**22.53**		**%increase '99-'06**	**-26.15**	**-19.95**	
35-44yrs	**Male**	**Female**	**Ratio: Male: Female**				
1999	38.34	22.26	1.72				
2000	42.82	23.81	1.80				
2001	40.99	25.46	1.61				
2002	42.97	26.79	1.60				
2003	39.54	25.54	1.55				
2004	40.31	26.07	1.55				
2005	44.56	27.73	1.61				
2006	47.46	30.93	1.53				
% increase '99-'06	**23.79**	**38.95**					

Appendix 4: Confidence interval for age standardised alcohol-related hospitalisation rates for Māori males in New Zealand

	1999	2000	2001	2002	2003	2004	2005	2006
0-14	**3.61**	**6.66**	**5.93**	**6.92**	**5.28**	**4.06**	**4.08**	**3.29**
LCI	2.10	4.56	3.97	4.79	3.45	2.48	2.49	1.88
UCI	5.78	9.40	8.52	9.67	7.74	6.28	6.30	5.34
15-24	**61.87**	**67.25**	**74.54**	**79.71**	**72.39**	**71.28**	**74.20**	**80.71**
LCI	54.18	59.20	66.11	71.07	64.25	63.31	66.15	72.37
UCI	70.35	76.09	83.75	89.11	81.27	79.98	82.95	89.74
25-34	**73.51**	**82.94**	**86.09**	**84.81**	**79.18**	**88.41**	**80.76**	**79.52**
LCI	64.03	72.92	75.94	74.68	69.34	77.91	70.72	69.59
UCI	83.99	93.95	97.22	95.93	90.03	99.92	91.82	90.46
35-44	**73.28**	**69.78**	**67.67**	**68.35**	**60.50**	**64.46**	**86.83**	**81.38**
LCI	62.56	59.50	57.68	58.40	51.23	54.92	75.69	70.59
UCI	85.32	81.31	78.89	79.50	70.96	75.19	99.16	93.35
45-54	**75.54**	**62.42**	**61.28**	**55.90**	**48.98**	**53.32**	**59.72**	**54.53**
LCI	62.98	51.30	50.55	45.90	39.81	43.94	49.93	45.35
UCI	89.88	75.23	73.61	67.43	59.63	64.11	70.87	65.02
55-64	**55.15**	**61.17**	**42.41**	**44.46**	**43.55**	**41.68**	**33.92**	**35.32**
LCI	43.66	49.19	32.66	34.66	34.07	32.61	25.94	27.32
UCI	68.74	75.19	54.16	56.17	54.85	52.49	43.57	44.94
65+	**85.34**	**91.07**	**85.22**	**79.41**	**60.93**	**55.84**	**59.00**	**61.97**
LCI	64.63	70.13	65.48	60.88	45.22	41.17	44.32	47.28
UCI	110.57	116.29	109.03	101.80	80.33	74.04	76.99	79.76

Appendix 5: Confidence interval for age standardised hospitalisation rates for Māori females in New Zealand

Age group	Year of diagnosis							
	1999	2000	2001	2002	2003	2004	2005	2006
0-14	**4.4**	**7.0**	**6.7**	**7.5**	**3.2**	**3.9**	**4.7**	**5.2**
LCI	2.7	4.8	4.5	5.2	1.8	2.3	3.0	3.3
UCI	6.9	9.9	9.5	10.4	5.3	6.1	7.2	7.7
15-24	**27.9**	**38.3**	**37.0**	**39.1**	**40.5**	**43.0**	**42.2**	**50.2**
LCI	22.8	32.3	31.2	33.2	34.5	36.9	36.3	43.7
UCI	33.7	45.0	43.6	45.8	47.2	49.8	48.8	57.3
25-34	**41.1**	**51.8**	**40.9**	**40.0**	**50.1**	**37.9**	**42.4**	**41.6**
LCI	34.4	44.4	34.4	33.5	42.8	31.5	35.6	34.9
UCI	48.7	60.2	48.4	47.4	58.4	45.2	50.1	49.2
35-44	**42.8**	**46.8**	**52.5**	**48.4**	**42.7**	**39.8**	**50.6**	**60.3**
LCI	35.1	38.8	44.1	40.4	35.3	32.7	42.6	51.6
UCI	51.7	55.9	62.0	57.4	51.1	47.9	59.6	70.1
45-54	**28.5**	**25.9**	**28.0**	**25.1**	**29.1**	**27.6**	**27.7**	**33.3**
LCI	21.1	19.1	21.1	18.8	22.4	21.2	21.4	26.5
UCI	37.5	34.3	36.4	33.0	37.3	35.4	35.2	41.3
55-64	**12.6**	**12.9**	**14.3**	**16.8**	**17.7**	**12.5**	**17.1**	**16.8**
LCI	7.6	7.9	9.1	11.1	12.0	7.9	11.8	11.6
UCI	19.7	19.9	21.5	24.2	25.2	18.8	24.0	23.5
65+	**19.7**	**16.4**	**14.5**	**16.9**	**15.0**	**14.3**	**13.6**	**9.5**
LCI	11.2	9.0	7.7	9.6	8.4	8.0	7.6	4.7
UCI	32.0	27.5	24.7	27.4	24.8	23.6	22.4	16.9

Appendix 6: Summary of Age standardised rates for urban and rural males in alcohol hospitalisation, ratios and percentage increase

Age Group 0-14 yrs	Male-Urban	Male-Rural	Ratio: urban male :rural males	Age Group 45-54yrs	Male-Urban	Male-Rural	Ratio: urban male :rural males
1999	3.89	1.94	2.01	1999	40.76	23.04	1.77
2000	5.37	4.23	1.27	2000	38.92	23.05	1.69
2001	4.72	1.64	2.88	2001	40.39	18.14	2.23
2002	4.37	2.20	1.99	2002	38.80	16.38	2.37
2003	3.93	2.52	1.56	2003	37.38	15.96	2.34
2004	2.95	1.57	1.88	2004	35.58	14.35	2.48
2005	2.68	3.11	0.86	2005	37.76	13.66	2.76
2006	3.02	1.67	1.81	2006	44.69	14.83	3.01
Percentage de/increase '99-'06	**-22.48**	**-13.92**		**Percentage de/increase '99-'06**	**9.65**	**-35.63**	
15-24yrs	**Male-Urban**	**Male-Rural**	**Ratio: urban male :rural males**	**55-64yrs**	**Male-Urban**	**Male-Rural**	**Ratio: urban male :rural males**
1999	43.31	38.47	1.13	1999	35.27	24.03	1.47
2000	54.74	38.50	1.42	2000	32.83	21.44	1.53
2001	57.06	49.15	1.16	2001	30.63	17.80	1.72
2002	54.62	35.81	1.53	2002	29.02	17.02	1.71
2003	53.88	37.78	1.43	2003	31.54	17.59	1.79
2004	56.51	34.10	1.66	2004	29.71	16.44	1.81
2005	65.79	41.33	1.59	2005	30.03	12.15	2.47
2006	63.45	43.63	1.45	2006	32.61	12.55	2.60
% increase '99-'06	**46.50**	**13.41**		**%'99-'06**	**-7.52**	**-47.77**	
25-34yrs	**Male-Urban**	**Male-Rural**	**Ratio: urban male :rural males**	**65+yrs**	**Male-Urban**	**Male-Rural**	**Ratio: urban male :rural males**
1999	43.82	30.11	1.46	1999	66.21	40.60	1.63
2000	48.78	36.99	1.32	2000	58.82	37.62	1.56
2001	49.91	41.27	1.21	2001	53.39	43.03	1.24
2002	47.24	25.36	1.86	2002	48.56	30.22	1.61
2003	46.54	33.41	1.39	2003	47.53	31.08	1.53
2004	50.49	31.02	1.63	2004	46.67	27.27	1.71
2005	52.79	25.29	2.09	2005	44.60	27.66	1.61
2006	47.91	28.65	1.67	2006	49.42	30.56	1.62
%increase '99-'06	**9.33**	**-4.85**		**%increase'99-06**	**-25.36**	**-24.73**	
35-44yrs	**Male-Urban**	**Male-Rural**	**Ratio: urban male :rural males**				
1999	42.83	21.88	1.96				
2000	46.94	23.23	2.02				
2001	43.90	26.98	1.63				
2002	44.50	22.76	1.96				
2003	41.65	19.78	2.11				
2004	43.16	19.25	2.24				
2005	46.11	25.08	1.84				
2006	52.18	16.97	3.07				
% increase '99-06	**21.82**	**-22.44**					

Appendix 7: Summary of Age standardised rates for urban and rural females in alcohol hospitalisation, ratios and percentage increase.

Age group 0-14 yrs	Female-Urban	Female-Rural	Ratio:Female-urban/Female-Rural	45-54yrs	Female-Urban	Female-Rural	Ratio:Female-urban/Female-Rural
1999	3.83	1.38	2.78	1999	15.23	9.20	1.66
2000	6.43	3.82	1.68	2000	16.56	11.34	1.46
2001	6.26	3.49	1.79	2001	18.19	10.01	1.82
2002	5.95	2.09	2.85	2002	15.48	9.17	1.69
2003	4.23	1.67	2.53	2003	18.75	9.48	1.98
2004	3.26	1.99	1.64	2004	18.88	6.28	3.01
2005	4.11	2.63	1.56	2005	19.62	6.89	2.85
2006	4.55	3.17	1.44	2006	22.44	12.54	1.79
% increase '99-'06	**18.80**	**129.71**		**% increase '99-'06**	**47.34**	**36.30**	
15-24yrs	**Female-Urban**	**Female-Rural**	**Ratio:Female-urban/Female-Rural**	**55-64yrs**	**Female-Urban**	**Female-Rural**	**Ratio:Female-urban/Female-Rural**
1999	20.10	18.66	1.08	1999	8.57	7.26	1.18
2000	26.75	18.05	1.48	2000	9.69	4.19	2.31
2001	29.60	30.98	0.96	2001	10.32	4.71	2.19
2002	32.26	25.40	1.27	2002	7.94	9.09	0.87
2003	33.14	20.83	1.59	2003	10.39	7.59	1.37
2004	35.39	20.47	1.73	2004	10.25	4.46	2.30
2005	38.61	23.72	1.63	2005	11.87	5.62	2.11
2006	39.06	24.00	1.63	2006	11.24	3.45	3.26
% increase '99-'06	**94.33**	**28.62**		**% increase '99-'06**	**31.16**	**-52.48**	
25-34yrs	**Female-Urban**	**Female-Rural**	**Ratio:Female-urban/Female-Rural**	**65+yrs**	**Female-Urban**	**Female-Rural**	**Ratio:Female-urban/Female-Rural**
1999	21.27	12.97	1.64	1999	15.12	12.52	1.21
2000	23.11	15.07	1.53	2000	12.08	11.69	1.03
2001	24.34	10.82	2.25	2001	13.59	11.41	1.19
2002	22.97	10.18	2.26	2002	10.58	10.62	1.00
2003	23.59	19.81	1.19	2003	11.35	9.01	1.26
2004	22.68	12.59	1.80	2004	11.63	6.41	1.81
2005	23.71	13.68	1.73	2005	10.07	5.34	1.89
2006	25.60	15.96	1.60	2006	13.12	6.83	1.92
% increase '99-'06	**20.36**	**23.05**		**% increase '99-'06**	**-13.23**	**-45.45**	
35-44yrs	**Female-Urban**	**Female-Rural**	**Ratio:Female-urban/Female-Rural**				
1999	23.90	14.17	1.69				
2000	25.95	12.60	2.06				
2001	26.64	14.44	1.84				
2002	26.95	15.37	1.75				
2003	25.77	17.61	1.46				
2004	27.37	12.37	2.21				
2005	28.72	12.10	2.37				
2006	33.83	12.51	2.70				
% increase '99-'06	**41.55**	**-11.71**					

Appendix 8: Confidence intervals for age-standardised alcohol-related mortality for males in New Zealand

Age group	**Year**									
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
15-24	**0.24**	**0.19**	**0.12**	**0.11**	**0.07**	**0.04**	**0.05**	**0.04**	**0.07**	**0.09**
LCI	0.07	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01
UCI	0.57	0.51	0.41	0.38	0.33	0.27	0.30	0.27	0.33	0.36
25-34	**0.23**	**0.23**	**0.20**	**0.24**	**0.26**	**0.25**	**0.18**	**0.18**	**0.16**	**0.15**
LCI	0.07	0.07	0.05	0.07	0.08	0.08	0.04	0.04	0.03	0.03
UCI	0.56	0.56	0.52	0.58	0.62	0.60	0.50	0.50	0.48	0.46
35-44	**0.60**	**0.58**	**0.56**	**0.57**	**0.49**	**0.55**	**0.52**	**0.53**	**0.46**	**0.47**
LCI	0.29	0.28	0.26	0.27	0.22	0.27	0.25	0.25	0.21	0.22
UCI	1.10	1.07	1.03	1.05	0.94	1.02	0.97	0.97	0.87	0.88
45-54	**1.02**	**1.22**	**1.25**	**1.20**	**1.13**	**1.12**	**1.17**	**1.35**	**1.37**	**1.48**
LCI	0.58	0.74	0.77	0.73	0.69	0.69	0.73	0.89	0.91	1.00
UCI	1.66	1.88	1.91	1.84	1.75	1.73	1.77	1.98	1.99	2.11
55-64	**1.55**	**1.57**	**1.57**	**1.77**	**1.86**	**1.75**	**1.70**	**1.50**	**1.43**	**1.27**
LCI	1.00	1.02	1.03	1.19	1.28	1.19	1.16	1.01	0.96	0.83
UCI	2.29	2.30	2.30	2.53	2.62	2.48	2.40	2.15	2.05	1.85
65+	**2.72**	**2.54**	**2.28**	**2.40**	**2.56**	**3.32**	**3.27**	**3.03**	**2.81**	**2.82**
LCI	1.98	1.84	1.63	1.76	1.91	2.57	2.50	2.30	2.12	2.14
UCI	3.64	3.42	3.12	3.19	3.37	4.24	4.20	3.91	3.64	3.65

Appendix 9: Confidence intervals for age-standardised alcohol related mortality for females in New Zealand

Age group	Year									
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
15-24	**0.15**	**0.11**	**0.08**	**0.03**	**0.02**	**0.02**	**0.00**	**0.03**	**0.07**	**0.07**
LCI	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCI	0.43	0.38	0.33	0.25	0.22	0.22	0.00	0.26	0.32	0.32
25-34	**0.12**	**0.12**	**0.15**	**0.14**	**0.12**	**0.09**	**0.05**	**0.07**	**0.10**	**0.09**
LCI	0.02	0.02	0.03	0.02	0.02	0.01	0.00	0.00	0.01	0.01
UCI	0.38	0.38	0.44	0.42	0.39	0.34	0.29	0.31	0.37	0.34
35-44	**0.35**	**0.29**	**0.34**	**0.31**	**0.29**	**0.20**	**0.15**	**0.23**	**0.24**	**0.19**
LCI	0.13	0.09	0.12	0.11	0.10	0.05	0.03	0.07	0.08	0.05
UCI	0.76	0.67	0.73	0.69	0.66	0.52	0.45	0.55	0.56	0.49
45-54	**0.60**	**0.59**	**0.45**	**0.34**	**0.38**	**0.41**	**0.41**	**0.40**	**0.50**	**0.48**
LCI	0.28	0.28	0.19	0.12	0.15	0.17	0.18	0.18	0.24	0.24
UCI	1.12	1.09	0.91	0.74	0.79	0.82	0.81	0.79	0.89	0.87
55-64	**0.35**	**0.46**	**0.49**	**0.46**	**0.55**	**0.52**	**0.55**	**0.36**	**0.43**	**0.47**
LCI	0.12	0.19	0.22	0.20	0.26	0.25	0.27	0.15	0.20	0.23
UCI	0.77	0.92	0.95	0.90	1.01	0.97	0.99	0.72	0.81	0.86
65+	**0.85**	**0.79**	**0.75**	**0.65**	**0.96**	**1.33**	**1.53**	**1.33**	**1.26**	**1.13**
LCI	0.46	0.42	0.39	0.33	0.57	0.87	1.03	0.87	0.82	0.72
UCI	1.44	1.36	1.30	1.13	1.51	1.96	2.18	1.94	1.84	1.68

Appendix 10: Confidence intervals for female Māori and non- Māori

Ethnicity by gender	Year							
	1997	1998	1999	2000	2001	2002	2003	2004
Female Maori	**2.36**	**1.81**	**3.34**	**3.34**	**3.67**	**3.27**	**3.60**	**3.14**
LCI	0.68	0.45	1.08	1.08	1.18	1.20	1.44	1.18
UCI	5.84	4.82	7.80	7.80	8.56	7.13	7.41	6.70
Female Non-Maori	**2.06**	**1.82**	**2.14**	**2.36**	**2.48**	**2.17**	**2.33**	**2.21**
LCI	1.43	1.24	1.51	1.71	1.82	1.57	1.71	1.62
UCI	2.87	2.58	2.94	3.17	3.29	2.92	3.09	2.95

Appendix 11: **Confidence intervals for age-standardised rates of alcohol-related mortality for males and females and urban/rural location in New Zealand**

Gender by location	Year									
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Male Urban	**5.96**	**5.76**	**5.40**	**6.12**	**6.56**	**7.29**	**6.70**	**6.16**	**5.74**	**5.81**
LCI	4.84	4.67	4.36	4.93	5.34	6.01	5.51	5.05	4.71	4.75
UCI	7.26	7.03	6.61	7.51	7.97	8.75	8.08	7.44	6.94	7.03
Male Rural	**4.52**	**5.00**	**5.34**	**5.82**	**4.92**	**4.70**	**3.98**	**4.97**	**5.77**	**6.35**
LCI	2.31	2.61	2.91	3.28	2.69	2.55	2.07	2.82	3.63	4.03
UCI	7.96	8.67	8.95	9.54	8.26	7.94	6.90	8.11	8.70	9.53
Female Urban	**2.07**	**1.99**	**2.00**	**1.72**	**2.14**	**2.33**	**2.37**	**2.05**	**2.16**	**2.10**
LCI	1.43	1.37	1.37	1.16	1.52	1.69	1.73	1.48	1.59	1.59
UCI	2.90	2.80	2.81	2.45	2.93	3.13	3.17	2.77	2.88	2.72
Female Rural	**2.10**	**1.95**	**0.92**	**0.84**	**1.18**	**1.29**	**2.05**	**1.76**	**2.34**	**1.77**
LCI	0.57	0.56	0.16	0.15	0.27	0.29	0.69	0.57	0.79	0.76
UCI	5.38	4.81	2.84	2.61	3.28	3.58	4.67	4.11	5.32	3.49

Appendix 12: Count of Alcohol outlets divided by deprivation quintiles by seven categories of urban and rural

		Deprivation Quintiles					
Urban areas	**Category**	**Low Deprivation 1**	**2**	**3**	**4**	**High Deprivation 5**	**Ratio Q5/Q1**
Main	Bottle Stores	62	99	142	207	205	**3.3**
	Hotel/Taverns/Bars	130	176	396	760	672	**5.2**
	Supermarkets and general stores/dairies	50	63	98	147	163	**3.3**
Satellite	Bottle Stores	0	2	3	8	16	**8.0***
	Hotel/Taverns/Bars	1	14	24	66	41	**41.0**
	Supermarkets and general stores/dairies	0	3	8	15	16	**5.3***
Independent	Bottle Stores	9	8	19	50	44	**4.9**
	Hotel/Taverns/Bars	37	71	108	359	304	**8.2**
	Supermarkets and general stores/dairies	5	14	27	79	67	**13.4**
	Total	**294**	**450**	**825**	**1 691**	**1 528**	**5.2**
Rural areas							
High urban influence	Bottle Stores	1	3	2	0	0	**0.0**
	Hotel/Taverns/Bars	23	8	15	6	4	**0.2**
	Supermarkets and general stores/dairies	7	3	4	1	3	**0.4**
Moderate urban influence	Bottle Stores	2	3	1	2	2	**1.0**
	Hotel/Taverns/Bars	14	35	30	31	18	**1.3**
	Supermarkets and general stores/dairies	0	5	6	5	1	**1**
Low urban influence	Bottle Stores	7	7	5	3	4	**0.6**
	Hotel/Taverns/Bars	23	82	91	115	73	**3.2**
	Supermarkets and general stores/dairies	1	8	15	23	18	**18.0**
Highly rural/Remote	Bottle Stores	0	2	1	0	2	**2**
	Hotel/Taverns/Bars	7	61	55	67	25	**3.6**
	Supermarkets and general stores/dairies	2	6	7	19	7	**3.5**
	Total	**87**	**223**	**232**	**272**	**157**	**1.8**

- ***Comparison quintile five and two**

Appendix 13: Sample distributions and prevalence of frequent consumption of five or more drinks from respondents aged 15 years and above from NZHS 2006/07.

Socio demographic characteristics		Percent of sample (n=10,012)	% Frequent consumption of five or more drinks (Overall 26.4%)	p value (two tallied χ^2)
Age group	15-24	13.7	43.6	
	25-34	17.1	34.9	
	35-44	20.9	26.2	
	45-54	17.0	21.6	
	55-64	14.2	18.5	
	65-74	10.0	12.2	
	75+	7.2	4.8	ρ <0.000
Gender	Female	54.9	16.0	
	Male	45.1	36.3	ρ <0.000
Ethnicity	Māori and Pacific Island persons	31.2	42.9	
	Asian	8.7	11.4	
	European/other	60.1	24.6	ρ <0.000
Personal Income	0-20,000	39.1	22.7	
	20,001-40,000	29.0	28.4	
	40,001-80,000	25.4	30.0	
	>80,001	6.6	31.1	ρ <0.000
Individual deprivation	1 No deprivation characteristic	63.2	24.4	
	2 One deprivation characteristic	17.1	27.7	
	3 Two deprivation characteristics	8.0	35.1	
	4 3/4 deprivation characteristics	7.8	33.3	
	5 Five deprivation characteristics	3.9	35.1	ρ <0.000
Contextual factors				
Location	Urban	85.9	26.6	
	Rural	14.1	26.1	ρ <0.996
Area Deprivation	1	17.6	23.7	
	2	18.2	22.8	
	3	20.5	26.0	
	4	21.5	27.4	
	5	22.2	35.1	ρ <0.000
Access measures	Distance to alcohol outlets			
	1 = <571 metres	24.2	27.8	
	2 = 572-995metres	28.9	26.3	
	3 = 992-2160metres	30.2	27.4	
	4 = >2161 metres	16.8	23.5	ρ <0.241
	Buffers of 800metres to alcohol outlets			
	0 =No Outlets	37.4	25.9	
	1 =1-2 Outlets	26.2	25.7	
	2 = 3-6 outlets	21.9	26.4	
	3=7+ outlets	14.5	29.7	ρ <0.075
	Buffers of 3000metres to alcohol outlets			
	0 = No Outlet	9.7	24.7	
	1 = 1-13 outlets	29.1	26.7	
	2 = 14-37 outlets	33.2	24.7	
	3 = 38+ outlets	28.0	29.0	ρ <0.013

Appendix 14: Summary descriptive statistics by ethnic groups

	Female European			Female Māori and Pacific Island Person			Male Europeans			Male Māori and Pacific Island Person		
Personal Income	%	UCI	LCI	%	UCI	LCI	%	UCI	LCI	%	UCI	LCI
0-20000	48.8	47.2	50.5	56.2	54.2	58.3	27.6	26.0	29.2	35.5	33.1	37.9
20001-40000	28.4	26.9	29.9	29.3	27.4	31.1	25.6	24.0	27.2	30.5	28.2	32.8
40001-80000	19.4	18.1	20.7	12.8	11.5	14.2	33.2	31.4	34.9	29.2	26.9	31.5
80001+	3.3	2.7	3.9	1.6	1.1	2.2	13.6	12.4	14.9	4.8	3.7	5.8
Individual Deprivation												
1 No dep characteristic	67.0	65.4	68.5	38.8	36.8	40.7	77.1	75.6	78.7	51.4	48.9	53.9
2 One dep characteristic	17.3	16.1	18.5	20.3	18.7	22.0	12.3	11.1	13.5	20.9	18.8	22.9
3 Two dep characteristics	6.8	6.0	7.6	13.8	12.3	15.2	5.0	4.2	5.8	9.6	8.1	11.1
4 3 or 4 dep characteristics	5.9	5.1	6.6	17.4	15.8	18.9	3.8	3.1	4.5	11.9	10.2	13.5
5 Five dep characteristics	3.1	2.6	3.7	9.8	8.6	11.0	1.8	1.3	2.3	6.2	5	7.5
Urban	84.3	83.1	85.5	87.4	86.0	88.7	83.7	82.4	85.1	86	84.2	87.7
Rural	15.7	14.5	16.9	12.6	11.3	14.0	16.3	14.9	17.6	14	12.3	15.8
Area deprivation												
1 Least	21.1	19.7	22.4	6.9	5.9	8.0	22.3	20.8	23.8	8.6	7.2	10
2	20.6	19.2	21.9	9.5	8.3	10.7	21.1	19.6	22.6	12.3	10.7	14
3	22.3	21.0	23.7	16.0	14.5	17.5	22.9	21.4	24.5	14.4	12.6	16.2
4	21.5	20.2	22.9	21.9	20.2	23.6	18.8	17.4	20.3	22.8	20.7	24.9
5 Most	14.5	13.4	15.7	45.7	43.7	47.8	14.8	13.5	16.1	41.9	39.4	44.4

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Appendix 15: Binary logistic regression of distance to alcohol outlets on hazardous consumption by gender while adjusting for a range of individual characteristics and contextual variables.

		Male					Female				
		Distance to alcohol outlets									
	Distance	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**
Baseline	**Odds Ratio**	**1**	0.88	0.96	0.83	0.96	**1**	1.18	0.87	**0.69**	0.88
	LCI		0.70	0.77	0.64	0.89		0.86	0.64	0.48	0.79
	UCI		1.11	1.21	1.09	1.04		1.61	1.17	0.99	0.97
	p value		0.29	0.76	0.18	0.34		0.31	0.35	**0.05**	**0.01**
Model 1 Age	**Odds Ratio**	**1**	0.93	1.05	0.94	1.00	**1**	1.22	0.89	0.75	0.90
	LCI		0.73	0.83	0.72	0.92		0.89	0.65	0.52	0.80
	UCI		1.18	1.33	1.23	1.09		1.67	1.22	1.09	1.00
	p value		0.53	0.70	0.65	0.98		0.22	0.48	0.13	**0.05**
Model 2 Ethnicity	**Odds Ratio**	**1**	0.93	1.04	0.91	0.99	**1**	1.18	0.85	0.73	0.88
	LCI		0.73	0.82	0.69	0.91		0.85	0.62	0.50	0.79
	UCI		1.19	1.32	1.20	1.08		1.65	1.17	1.07	0.99
	p value		0.57	0.74	0.50	0.83		0.31	0.31	0.10	**0.03**
Model 3 Personal Income	**Odds Ratio**	**1**	0.97	1.09	0.94	1.00	**1**	1.18	0.84	0.74	0.89
	LCI		0.76	0.86	0.71	0.92		0.85	0.61	0.51	0.79
	UCI		1.24	1.39	1.24	1.09		1.65	1.17	1.08	0.99
	p value		0.80	0.48	0.65	0.95		0.32	0.31	0.12	**0.03**
Model 4 Individual deprivation	**Odds Ratio**	1	0.98	1.12	0.98	1.02	1	1.16	0.87	0.80	0.91
	LCI		0.76	0.88	0.74	0.93		0.83	0.63	0.55	0.81
	UCI		1.25	1.43	1.31	1.11		1.61	1.2	1.17	1.02
	p value		0.85	0.37	0.91	0.68		0.38	0.39	0.25	0.10
Model 5 Urban/rural	**Odds Ratio**	1	0.98	1.12	0.87	1.01	1	1.16	0.87	0.87	0.93
	LCI		0.76	0.88	0.61	0.91		0.83	0.63	0.53	0.81
	UCI		1.26	1.43	1.23	1.11		1.61	1.20	1.42	1.06
	p value		0.87	0.36	0.42	0.91		0.38	0.39	0.58	0.28
Model 6 Area deprivation	**Odds Ratio**	1	0.99	1.12	0.89	1.01	1	1.18	0.90	0.91	0.94
	LCI		0.77	0.87	0.62	0.92		0.85	0.65	0.55	0.82
	UCI		1.29	1.44	1.29	1.12		1.65	1.25	1.49	1.08
	p value		0.96	0.36	0.55	0.82		0.32	0.54	0.70	0.40

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 16: Binary logistic regression of distance to alcohol outlets on hazardous consumption by ethnicity, gender and age group

		Male European					Male Māori and Pacific Island persons					Female European					Female Māori and Pacific Island persons				
		Distance to alcohol outlets																			
	Distance	<571m	572-995m	996m-2.1km	>2.2km	Test of trends	<571m	572-995m	996m-2.1km	>2.2km	Test of trends	<571m	572-995m	996m-2.1km	>2.2km	Test of trends	<571m	572-995m	996m-2.1km	>2.2km	Test of trends
15-24	**Odds Ratio**	1	1.09	1.26	0.85	1.00	1	0.76	0.52	**0.30**	0.68	1	1.99	0.63	0.61	0.76	1	1.07	1.02	1.11	1.02
	LCI		0.50	0.58	0.36	0.77		0.34	0.24	0.11	0.50		0.87	0.26	0.20	0.56		0.58	0.55	0.52	0.81
	UCI		2.37	2.73	1.99	1.30		1.67	1.13	0.85	0.92		4.56	1.55	1.81	1.03		1.98	1.89	2.39	1.28
	p value		0.83	0.56	0.70	0.99		0.49	0.10	**0.02**	**0.01**		0.10	0.32	0.37	0.08		0.82	0.96	0.78	0.87
25-34	**Odds Ratio**	1	0.59	0.78	0.53	0.85	1	1.08	1.60	1.73	1.24	1	1.99	0.63	0.61	0.76	1	1.15	1.04	1.24	1.05
	LCI		0.28	0.38	0.21	0.65		0.50	0.72	0.68	0.92		0.87	0.26	0.20	0.56		0.55	0.50	0.51	0.80
	UCI		1.28	1.63	1.33	1.13		2.33	3.59	4.41	1.65		4.56	1.55	1.81	1.03		2.41	2.16	3.05	1.38
	p value		0.18	0.51	0.18	0.27		0.85	0.25	0.25	0.16		0.10	0.32	0.37	0.08		0.71	0.92	0.64	0.74
35-44	**Odds Ratio**	1	0.71	1.04	0.94	1.02	1	0.74	0.59	0.51	0.79	1	1.15	0.69	0.39	0.75	1	0.47	0.89	0.93	1.06
	LCI		0.39	0.57	0.50	0.84		0.37	0.31	0.23	0.62		0.48	0.26	0.14	0.56		0.21	0.43	0.36	0.78
	UCI		1.32	1.90	1.78	1.26		1.47	1.10	1.15	1.01		2.78	1.83	1.14	0.99		1.05	1.84	2.40	1.44
	p value		0.28	0.90	0.86	0.81		0.38	0.10	0.11	0.06		0.75	0.46	0.09	**0.05**		0.07	0.75	0.88	0.70
45-54	**Odds Ratio**	1	0.81	0.60	0.95	0.95	1	0.78	0.54	0.58	0.81	1	1.13	1.22	0.98	0.99	1	0.86	0.40	0.31	0.64
	LCI		0.38	0.29	0.46	0.74		0.25	0.17	0.18	0.56		0.37	0.47	0.35	0.73		0.29	0.15	0.06	0.43
	UCI		1.71	1.26	1.95	1.22		2.43	1.67	1.84	1.17		3.46	3.13	2.73	1.35		2.57	1.12	1.53	0.97
	p value		0.58	0.18	0.88	0.67		0.67	0.28	0.36	0.26		0.83	0.68	0.97	0.97		0.79	0.08	0.15	0.04
55-64	**Odds Ratio**	1	1.21	1.21	0.85	0.95	1	0.78	0.98	0.53	0.87	1	3.21	2.08	1.99	1.10	1	0.88	0.84	1.95	1.23
	LCI		0.61	0.62	0.35	0.74		0.15	0.21	0.10	0.53		0.75	0.48	0.34	0.72		0.16	0.14	0.32	0.63
	UCI		2.40	2.37	2.08	1.22		3.96	4.51	2.96	1.43		13.85	9.01	11.63	1.68		4.75	5.03	12.02	2.39
	p value		0.58	0.58	0.72	0.70		0.77	0.98	0.47	0.58		0.12	0.33	0.45	0.66		0.88	0.85	0.47	0.55
65-74	**Odds Ratio**	1	0.71	0.79	0.53	0.86	1	0.82	1.11	0.79	0.99	1	2.27	1.93		0.83	1	0.31	0.61	1.23	0.99
	LCI		0.29	0.34	0.19	0.63		0.13	0.17	0.06	0.46		0.35	0.30		0.54		0.02	0.04	0.08	0.32
	UCI		1.76	1.85	1.50	1.17		5.10	7.07	10.83	2.12		14.90	12.29		1.27		4.48	8.53	18.61	3.03
	p value		0.46	0.59	0.23	0.32		0.83	0.91	0.86	0.97		0.39	0.49		0.38		0.39	0.72	0.88	0.99
75+	**Odds Ratio**	1	1.72	1.58		0.90	1			2.05	0.96	1	2.81	1.19		0.88	1				
	LCI		0.51	0.43		0.60				0.09	0.17		0.54	0.11		0.51					
	UCI		5.77	5.73		1.35				47.91	5.44		14.60	13.48		1.54					
	p value		0.38	0.49		0.61				0.65	0.96		0.22	0.89		0.66					

LCI =Lower Confidence Interval UCI=Upper Confidence Interval Bold figures indicate statistically significant associations (p <0.05)

Appendix 17: Binary logistic regression of distance to alcohol outlets on hazardous consumption by location while adjusting for a range of individual characteristics and contextual variables.

		Urban					Rural				
		Distance to alcohol outlets									
		<571m	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**
Baseline Model	**Odds Ratio**	1	0.97	0.94	0.77	0.94	1	0.97	1.15	0.87	0.94
	LCI		0.80	0.78	0.57	0.87		0.41	0.53	0.48	0.79
	UCI		1.18	1.13	1.04	1.02		2.30	2.48	1.57	1.12
	p value		0.75	0.52	0.09	0.15		0.94	0.72	0.64	0.48
Model 1 Age and Gender	**Odds Ratio**	1	1.04	0.99	0.90	0.98	1	1.10	1.53	0.81	0.89
	LCI		0.85	0.82	0.66	0.90		0.35	0.65	0.42	0.73
	UCI		1.28	1.21	1.21	1.06		3.42	3.64	1.57	1.09
	p value		0.70	0.95	0.47	0.59		0.88	0.33	0.54	0.25
Model 2 Ethnicity	**Odds Ratio**	1	1.04	0.97	0.87	0.98	1	1.13	1.60	0.86	0.91
	LCI		0.84	0.79	0.64	0.90		0.35	0.67	0.44	0.74
	UCI		1.28	1.18	1.17	1.06		3.59	3.83	1.70	1.11
	p value		0.74	0.76	0.35	0.59		0.84	0.30	0.67	0.34
Model 3 Personal income	**Odds Ratio**	1	1.06	1.00	0.89	0.98	1	1.31	1.71	0.91	0.91
	LCI		0.85	0.81	0.66	0.90		0.40	0.67	0.43	0.73
	UCI		1.31	1.22	1.21	1.06		4.23	4.36	1.92	1.12
	p value		0.61	0.97	0.46	0.58		0.66	0.26	0.81	0.36
Model 4 Individual deprivation	**Odds Ratio**	1	1.05	1.02	0.93	0.99	1	1.48	1.71	0.98	0.92
	LCI		0.85	0.83	0.68	0.91		0.44	0.62	0.45	0.74
	UCI		1.30	1.24	1.26	1.07		4.97	4.67	2.13	1.15
	p value		0.66	0.87	0.63	0.81		0.53	0.30	0.96	0.46
Model 5 Area Deprivation	**Odds Ratio**	1	1.08	1.04	0.98	1.00	1	1.59	1.96	1.04	0.92
	LCI		0.87	0.85	0.71	0.92		0.46	0.72	0.45	0.73
	UCI		1.34	1.28	1.34	1.09		5.46	5.34	2.38	1.17
	p value		0.50	0.72	0.88	0.95		0.46	0.19	0.93	0.50

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 18: Binary logistic regression of distance to alcohol outlets on hazardous consumption in national and urban/rural areas by gender while adjusting for a range of individual characteristics and contextual variables.

		Urban										Rural									
		Male					Female					Male					Female				
		Distance to alcohol outlets																			
	Distance	<571m	572-995m	996m-2.1km	>2.2km	Test of trends	<571m	572-995m	996m-2.1km	>2.2km	Test of trends	<571m	572-995m	996m-2.1km	>2.2km	Test of trends	<571m	572-995m	996m-2.1km	>2.2km	Test of trends
Baseline	Odds Ratio	1	0.88	0.96	0.83	0.96	1	1.18	0.87	**0.69**	0.88	1	0.98	**2.95**	1.40	1.07	1	1.01	**0.20**	**0.38**	0.71
	LCI		0.70	0.77	0.64	0.89		0.86	0.64	0.48	0.79		0.32	1.00	0.61	0.86		0.25	0.06	0.16	0.52
	UCI		1.11	1.21	1.09	1.04		1.61	1.17	0.99	0.97		3.01	8.72	3.24	1.34		4.02	0.67	0.94	0.96
	p value		0.29	0.76	0.18	0.34		0.31	0.35	**0.05**	**0.01**		0.98	**0.05**	0.43	0.55		0.99	**0.01**	**0.04**	**0.03**
Model 1	Odds Ratio	1	0.93	1.05	0.94	1.00	1	1.22	0.89	0.75	0.90	1	0.88	**4.08**	1.32	1.04	1	0.92	**0.18**	**0.30**	0.65
Age	LCI		0.73	0.83	0.72	0.92		0.89	0.65	0.52	0.80		0.26	1.22	0.55	0.83		0.20	0.05	0.12	0.46
	UCI		1.18	1.33	1.23	1.09		1.67	1.22	1.09	1.00		2.96	13.66	3.20	1.31		4.30	0.66	0.77	0.90
	p value		0.53	0.70	0.65	0.98		0.22	0.48	0.13	**0.05**		0.84	**0.02**	0.54	0.73		0.92	**0.01**	**0.01**	**0.01**
Model 2	Odds Ratio	1	0.93	1.04	0.91	0.99	1	1.18	0.85	0.73	0.88	1	0.91	**4.21**	1.36	1.05	1	1.01	**0.18**	**0.35**	0.68
Ethnicity	LCI		0.73	0.82	0.69	0.91		0.85	0.62	0.50	0.79		0.28	1.25	0.56	0.83		0.18	0.05	0.12	0.47
	UCI		1.19	1.32	1.20	1.08		1.65	1.17	1.07	0.99		3.02	14.12	3.28	1.31		5.56	0.71	1.01	0.98
	p value		0.57	0.74	0.50	0.83		0.31	0.31	0.10	**0.03**		0.88	**0.02**	0.50	0.70		0.99	**0.01**	**0.05**	**0.04**
Model 3	Odds Ratio	1	0.97	1.09	0.94	1.00	1	1.18	0.84	0.74	0.89	1	1.01	**4.65**	1.34	1.03	1	1.18	**0.12**	0.37	0.68
Personal Income	LCI		0.76	0.86	0.71	0.92		0.85	0.61	0.51	0.79		0.29	1.33	0.54	0.81		0.17	0.02	0.09	0.44
	UCI		1.24	1.39	1.24	1.09		1.65	1.17	1.08	0.99		3.48	16.18	3.36	1.29		8.04	0.66	1.56	1.06
	p value		0.80	0.48	0.65	0.95		0.32	0.31	0.12	**0.03**		0.99	**0.02**	0.53	0.83		0.87	**0.02**	0.18	0.09
Model 4	Odds Ratio	1	0.98	1.12	0.98	1.02	1	1.16	0.87	0.80	0.91	1	1.15	**4.30**	1.39	1.03	1	1.22	**0.12**	0.37	0.68
Individual deprivation	LCI		0.76	0.88	0.74	0.93		0.83	0.63	0.55	0.81		0.33	1.16	0.55	0.81		0.17	0.02	0.08	0.43
	UCI		1.25	1.43	1.31	1.11		1.61	1.20	1.17	1.02		4.08	15.88	3.50	1.31		9.01	0.74	1.61	1.07
	p value		0.85	0.37	0.91	0.68		0.38	0.39	0.25	0.10		0.83	**0.03**	0.49	0.80		0.84	**0.02**	0.19	0.09
Model 6	Odds Ratio	1	0.99	1.12	1.01	1.03	1	1.19	0.90	0.85	0.93	1	1.26	**4.94**	1.48	1.03	1	1.00	**0.11**	0.31	0.66
Area deprivation	LCI		0.77	0.87	0.75	0.94		0.85	0.65	0.57	0.82		0.33	1.37	0.55	0.79		0.15	0.02	0.07	0.42
	UCI		1.28	1.44	1.37	1.12		1.65	1.26	1.25	1.04		4.82	17.83	4.03	1.35		6.71	0.77	1.47	1.03
	p value		0.94	0.36	0.93	0.58		0.32	0.54	0.40	0.19		0.73	**0.02**	0.44	0.81		1.00	**0.03**	0.14	0.07

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (P= <0.05)

Appendix 19: Binary logistic regression of distance to alcohol outlets on hazardous consumption, nationally and in urban areas for all age groups

		Urban					**Rural**				
		Distance to alcohol outlets									
Age group		**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**
15-24	**Odds Ratio**	**1**	1.29	0.98	0.91	0.96	1	0.48	0.35	0.47	0.84
	LCI		0.86	0.65	0.48	0.82		0.08	0.05	0.12	0.55
	UCI		1.93	1.49	1.71	1.14		3.01	2.65	1.83	1.27
	p value		0.22	0.94	0.77	0.67		0.43	0.31	0.27	0.40
25-34	**Odds Ratio**	**1**	0.91	1.24	0.97	1.08	1	1.49	2.12	2.85	1.40
	LCI		0.61	0.84	0.51	0.92		0.18	0.26	0.45	0.89
	UCI		1.35	1.83	1.87	1.28		12.21	17.26	17.96	2.21
	p value		0.62	0.27	0.93	0.36		0.71	0.48	0.26	0.15
35-44	**Odds Ratio**	**1**	0.73	0.84	0.68	0.91	**1**	0.62	1.08	0.69	0.90
	LCI		0.50	0.58	0.40	0.78		0.18	0.31	0.27	0.68
	UCI		1.09	1.22	1.17	1.06		2.16	3.72	1.77	1.20
	p value		0.12	0.35	0.16	0.24		0.45	0.90	0.44	0.47
45-54	**Odds Ratio**	**1**	0.76	0.66	0.53	0.82	**1**	2.25	0.68	1.28	1.00
	LCI		0.46	0.40	0.24	0.66		0.33	0.14	0.34	0.66
	UCI		1.26	1.09	1.16	1.01		15.42	3.43	4.85	1.51
	p value		0.29	0.11	0.11	0.06		0.41	0.64	0.72	1.00
55-64	**Odds Ratio**	**1**	1.56	1.43	1.49	1.12	**1**	1.62	2.77	0.49	0.67
	LCI		0.89	0.82	0.58	0.89		0.29	0.44	0.09	0.46
	UCI		2.73	2.48	3.83	1.41		9.16	17.38	2.59	0.98
	p value		0.12	0.21	0.40	0.34		0.58	0.28	0.40	**0.04**
65-74	**Odds Ratio**	**1**	0.86	0.91	0.41	0.87	**1**		**13.6**	6.33	1.46
	LCI		0.42	0.46	0.14	0.67			1.31	0.69	0.83
	UCI		1.74	1.79	1.17	1.14			140.98	58.06	2.58
	p value		0.67	0.79	0.10	0.31			**0.03**	0.10	0.19
75+	**Odds Ratio**	**1**	2.35	1.80	0.42	1.15	**1**			0.52	0.36
	LCI		0.82	0.53	0.05	0.77				0.04	0.13
	UCI		6.71	6.13	3.53	1.73				7.06	0.96
	p value		0.11	0.35	0.43	0.49				0.62	**0.04**

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 20: Binary logistic regression of distance to alcohol outlets on frequent consumption of five drinks or more by gender while adjusting for a range of individual characteristics and contextual variables.

		Male					Female				
		Distance to alcohol outlets									
		<571m	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**
Baseline	**Odds Ratio**	1	0.86	0.94	0.87	0.97	1	1.07	0.99	0.74	0.92
	LCI		0.69	0.76	0.68	0.90		0.80	0.76	0.54	0.84
	UCI		1.07	1.16	1.11	1.05		1.42	1.30	1.01	1.01
	p value		0.18	0.57	0.25	0.42		0.66	0.95	0.06	0.07
Model 1 Age	**Odds Ratio**	1	0.89	1.00	0.95	1.00	1	1.10	1.02	0.77	0.93
	LCI		0.71	0.80	0.74	0.92		0.81	0.77	0.56	0.84
	UCI		1.12	1.24	1.23	1.08		1.48	1.35	1.07	1.03
	p value		0.33	0.97	0.70	0.97		0.54	0.91	0.12	0.15
Model 2 Ethnicity	**Odds Ratio**	1	0.90	0.99	0.91	0.99	1	1.07	0.98	0.75	0.92
	LCI		0.72	0.80	0.7	0.91		0.79	0.74	0.54	0.83
	UCI		1.13	1.23	1.18	1.07		1.45	1.30	1.04	1.02
	p value		0.35	0.92	0.47	0.72		0.68	0.89	0.09	0.10
Model 3 Personal Income	**Odds Ratio**	1	0.90	1.02	0.94	1.00	1	1.03	0.94	0.78	0.92
	LCI		0.71	0.81	0.73	0.92		0.75	0.7	0.56	0.84
	UCI		1.13	1.28	1.23	1.08		1.41	1.26	1.08	1.02
	p value		0.37	0.87	0.67	1.00		0.87	0.69	0.14	0.13
Model 4 Individual deprivation	**Odds Ratio**	1	0.90	1.02	0.96	1.00	1	1.01	0.96	0.82	0.94
	LCI		0.71	0.82	0.74	0.93		0.74	0.71	0.58	0.85
	UCI		1.13	1.28	1.25	1.09		1.39	1.29	1.14	1.04
	p value		0.37	0.84	0.75	0.91		0.95	0.77	0.24	0.25
Model 5 Urban/rural	**Odds Ratio**	1	0.90	1.03	0.77	0.97	1	1.01	0.96	0.70	0.92
	LCI		0.72	0.82	0.56	0.89		0.74	0.71	0.44	0.81
	UCI		1.14	1.29	1.07	1.06		1.39	1.29	1.11	1.04
	p value		0.39	0.82	0.12	0.49		0.94	0.77	0.13	0.19
Model 6 Area deprivation	**Odds Ratio**	1	0.93	1.04	0.81	0.98	1	1.04	1.02	0.77	0.95
	LCI		0.73	0.82	0.58	0.89		0.76	0.75	0.48	0.84
	UCI		1.18	1.31	1.13	1.08		1.42	1.38	1.23	1.08
	p value		0.54	0.74	0.21	0.65		0.82	0.89	0.27	0.45

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 21: Binary logistic regression of distance to alcohol outlets on frequent consumption of five or more alcoholic drinks by gender.

		Male					Female				
		Distance to alcohol outlets									
		<571m	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**
15-24	**Odds Ratio**	1	1.23	1.25	0.99	1.02	**1**	1.45	1.29	0.95	1.00
	LCI		0.72	0.74	0.51	0.84		0.83	0.74	0.49	0.82
	UCI		2.10	2.10	1.93	1.25		2.54	2.27	1.85	1.21
	p value		0.45	0.41	0.98	0.81		0.19	0.37	0.89	0.98
25-34	**Odds Ratio**	1	0.74	1.27	1.57	1.17	**1**	1.08	1.02	0.68	0.91
	LCI		0.44	0.75	0.81	0.96		0.66	0.62	0.36	0.76
	UCI		1.23	2.13	3.05	1.43		1.78	1.67	1.28	1.09
	p value		0.25	0.38	0.18	0.12		0.75	0.95	0.23	0.32
35-44	**Odds Ratio**	1	0.85	1.17	0.90	1.01	**1**	0.63	0.76	**0.40**	0.80
	LCI		0.54	0.75	0.56	0.87		0.37	0.46	0.22	0.66
	UCI		1.33	1.82	1.45	1.18		1.08	1.26	0.73	0.95
	p value		0.47	0.49	0.66	0.86		0.09	0.28	**0.00**	**0.01**
45-54	**Odds Ratio**	1	0.75	**0.50**	0.99	0.94	**1**	0.96	1.11	1.03	1.03
	LCI		0.43	0.29	0.58	0.78		0.44	0.54	0.49	0.82
	UCI		1.29	0.85	1.71	1.13		2.07	2.28	2.16	1.29
	p value		0.30	**0.01**	0.98	0.51		0.92	0.77	0.95	0.82
55-64	**Odds Ratio**	1	0.97	1.03	0.56	0.86	1	1.99	0.52	1.20	0.91
	LCI		0.56	0.60	0.30	0.72		0.74	0.18	0.42	0.66
	UCI		1.68	1.77	1.04	1.03		5.36	1.48	3.47	1.26
	p value		0.93	0.91	0.07	0.11		0.18	0.22	0.73	0.58
65-74	**Odds Ratio**	1	0.63	0.67	0.77	0.93	1	0.64	1.04	1.12	1.09
	LCI		0.30	0.34	0.36	0.72		0.12	0.26	0.22	0.62
	UCI		1.32	1.34	1.66	1.20		3.48	4.14	5.79	1.91
	p value		0.22	0.26	0.50	0.58		0.61	0.96	0.89	0.77
75+	**Odds Ratio**	1	1.01	1.22	0.32	0.90	1	1.20			0.49
	LCI		0.32	0.41	0.05	0.61		0.07			0.14
	UCI		3.18	3.63	1.85	1.34		19.49			1.70
	p value		0.98	0.72	0.20	0.61		0.90			0.26

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (P= <0.05)

Appendix 22: Binary logistic regression of distance to alcohol outlets and control variables on frequent consumption of five drinks or more by gender and specific age group (35-54 years) while adjusting for a range of individual characteristics and contextual variables

		35-44 years										45-54 years									
		Distance to alcohol outlets																			
		Male					Female					Male					Female				
		<571 m	572-995 m	996m - 2.1km	>2.2km	Test of trends	<571 m	572-995 m	996m - 2.1km	>2.2km	Test of trends	<571 m	572-995 m	996m - 2.1km	>2.2km	Test of trends	<571 m	572-995 m	996m - 2.1km	>2.2km	Test of trends
Baseline	**Odds Ratio**	1	0.85	1.17	0.90	1.01	1	0.63	0.76	0.40	0.80	1	0.75	0.50	0.99	0.94	1	0.96	1.11	1.03	1.03
	LCI		0.54	0.75	0.56	0.87		0.37	0.46	0.22	0.66		0.43	0.29	0.58	0.78		0.44	0.54	0.49	0.82
	UCI		1.33	1.82	1.45	1.18		1.08	1.26	0.73	0.95		1.29	0.85	1.71	1.13		2.07	2.28	2.16	1.29
	p value		0.47	0.49	0.66	0.86		0.09	0.28	0.00	0.01		0.30	0.01	0.98	0.51		0.92	0.77	0.95	0.82
Model 1	**Odds Ratio**	1	0.88	1.18	0.88	1.01	1	0.60	0.72	0.36	0.77	1	0.73	0.51	0.91	0.93	1	1.02	1.13	1.07	1.03
Ethnicity	**LCI**		0.56	0.75	0.54	0.86		0.34	0.42	0.20	0.64		0.42	0.29	0.52	0.77		0.46	0.54	0.50	0.82
	UCI		1.37	1.84	1.44	1.17		1.05	1.21	0.67	0.93		1.29	0.88	1.59	1.12		2.22	2.34	2.29	1.30
	p value		0.57	0.48	0.62	0.93		0.07	0.21	0.00	0.01		0.28	0.02	0.74	0.42		0.97	0.75	0.85	0.77
Model 2	**Odds Ratio**	1	0.82	1.09	0.86	0.99	1	0.58	0.69	0.38	0.78	1	0.71	0.52	0.94	0.94	1	0.97	1.10	1.01	1.02
Personal	**LCI**		0.51	0.68	0.52	0.85		0.33	0.40	0.20	0.64		0.40	0.30	0.53	0.78		0.44	0.53	0.48	0.81
income	**UCI**		1.30	1.73	1.42	1.16		1.01	1.18	0.70	0.94		1.26	0.93	1.66	1.14		2.12	2.26	2.15	1.28
	p value		0.39	0.73	0.56	0.94		0.06	0.18	0.00	0.01		0.24	0.03	0.83	0.56		0.93	0.80	0.98	0.87
Model 3	**Odds Ratio**	1	0.84	1.09	0.87	0.99	1	0.61	0.74	0.41	0.80	1	0.67	0.51	0.89	0.93	1	0.98	1.07	1.01	1.01
Individual	**LCI**		0.52	0.68	0.53	0.85		0.34	0.43	0.22	0.66		0.38	0.29	0.50	0.77		0.44	0.52	0.47	0.80
deprivation	**UCI**		1.34	1.74	1.44	1.16		1.07	1.28	0.78	0.97		1.20	0.90	1.59	1.13		2.15	2.22	2.15	1.28
	p value		0.45	0.72	0.58	0.94		0.08	0.28	0.01	0.03		0.18	0.02	0.70	0.48		0.95	0.85	0.99	0.91
Model 4	**Odds Ratio**	1	0.84	1.08	0.67	0.96	1	0.61	0.75	0.39	0.81	1	0.68	0.51	0.82	0.86	1	0.98	1.06	0.46	0.84
Urban/rural	**LCI**		0.52	0.68	0.39	0.81		0.34	0.43	0.18	0.65		0.38	0.29	0.41	0.69		0.45	0.50	0.17	0.63
	UCI		1.35	1.73	1.17	1.13		1.07	1.29	0.83	1.00		1.21	0.91	1.66	1.07		2.14	2.24	1.23	1.12
	p value		0.47	0.73	0.16	0.61		0.09	0.30	0.02	0.06		0.19	0.02	0.59	0.17		0.97	0.87	0.12	0.24
Model 6	**Odds Ratio**	1	0.86	1.12	0.71	0.97	1	0.66	0.85	0.49	0.87	1	0.67	0.52	0.85	0.86	1	1.04	1.10	0.48	0.86
Area	**LCI**		0.54	0.70	0.40	0.82		0.38	0.49	0.22	0.69		0.37	0.29	0.41	0.69		0.48	0.50	0.17	0.64
deprivation	**UCI**		1.38	1.79	1.26	1.16		1.16	1.47	1.10	1.09		1.21	0.94	1.75	1.08		2.28	2.40	1.32	1.15
	p value		0.53	0.63	0.24	0.75		0.15	0.55	0.08	0.23		0.19	0.03	0.66	0.20		0.91	0.82	0.15	0.31

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p <0.05)

Appendix 23: Binary logistic regression of distance to alcohol outlets on frequent consumption of five or more alcoholic drinks by ethnicity, gender & age group

		Male European					Male Māori and Pacific Island persons					Female European					Female Māori and Pacific Island persons				
		Distance to alcohol outlets																			
	Distance	<571m	572-995m	996m-2.1km	>2.2km	Test of trends	<571m	572-995m	996m-2.1km	>2.2km	Test of trends	<571m	572-995m	996m-2.1km	>2.2km	Test of trends	<571m	572-995m	996m-2.1km	>2.2km	Test of trends
15-24	**Odds Ratio**	1	1.39	1.60	1.12	1.10	1	0.96	0.65	0.67	0.84	1	1.46	1.32	0.82	0.96	1	1.47	0.93	1.06	0.97
	LCI		0.65	0.78	0.47	0.84		0.44	0.30	0.24	0.62		0.65	0.58	0.31	0.73		0.74	0.48	0.41	0.74
	UCI		3.00	3.31	2.67	1.43		2.08	1.39	1.89	1.13		3.25	3.01	2.16	1.26		2.92	1.83	2.75	1.27
	p value		0.39	0.20	0.79	0.50		0.92	0.27	0.45	0.25		0.36	0.51	0.69	0.75		0.27	0.84	0.91	0.83
25-34	**Odds Ratio**	1	0.78	1.43	1.55	1.21	1	0.83	1.02	1.20	1.05	1	0.96	1.32	0.82	0.88	1	1.47	0.93	1.06	0.97
	LCI		0.39	0.72	0.67	0.93		0.39	0.48	0.48	0.80		0.73	0.58	0.31	0.69		0.74	0.48	0.41	0.74
	UCI		1.57	2.82	3.59	1.57		1.74	2.20	2.95	1.38		1.26	3.01	2.16	1.11		2.92	1.83	2.75	1.27
	p value		0.49	0.31	0.31	0.16		0.62	0.95	0.70	0.72		0.75	0.51	0.69	0.28		0.27	0.84	0.91	0.83
35-44	**Odds Ratio**	1	0.87	1.24	0.95	1.03	1	0.90	0.75	0.53	0.83	1	0.65	0.77	**0.28**	0.74	1	**0.46**	0.57	0.62	0.89
	LCI		0.49	0.71	0.54	0.86		0.44	0.39	0.22	0.64		0.32	0.40	0.12	0.59		0.23	0.28	0.25	0.66
	UCI		1.54	2.16	1.70	1.24		1.84	1.44	1.28	1.07		1.32	1.49	0.66	0.93		0.94	1.17	1.57	1.19
	p value		0.64	0.45	0.88	0.73		0.77	0.39	0.16	0.14		0.24	0.44	**0.00**	**0.01**		**0.03**	0.13	0.32	0.42
45-54	**Odds Ratio**	1	0.74	0.56	0.96	0.95	1	0.79	0.39	0.75	0.84	1	1.04	1.29	1.11	1.05	1	0.96	0.75	1.08	0.96
	LCI		0.39	0.30	0.52	0.77		0.27	0.14	0.25	0.58		0.39	0.51	0.44	0.80		0.33	0.28	0.35	0.66
	UCI		1.40	1.04	1.78	1.17		2.26	1.08	2.24	1.21		2.80	3.24	2.82	1.38		2.81	2.00	3.31	1.39
	p value		0.36	0.07	0.90	0.64		0.66	0.07	0.61	0.34		0.93	0.59	0.83	0.72		0.94	0.56	0.89	0.83
55-64	**Odds Ratio**	1	0.95	1.03	0.50	0.84	1	0.75	0.79	0.83	0.96	1	2.06	0.54	1.05	0.88	1	1.51	0.38	2.71	1.25
	LCI		0.51	0.57	0.25	0.69		0.17	0.20	0.20	0.61		0.67	0.17	0.30	0.61		0.41	0.06	0.63	0.72
	UCI		1.75	1.88	1.02	1.03		3.29	3.06	3.44	1.51		6.36	1.75	3.72	1.26		5.57	2.33	11.73	2.17
	p value		0.86	0.92	0.06	0.09		0.70	0.73	0.80	0.87		0.21	0.31	0.94	0.48		0.53	0.30	0.18	0.43
65-74	**Odds Ratio**	1	0.76	0.76	0.84	0.95	1	**0.18**	0.62	0.77	0.84	1	0.79	1.13	1.28	1.13	1	0.21	0.57	0.81	0.88
	LCI		0.34	0.35	0.37	0.73		0.04	0.11	0.09	0.37		0.12	0.21	0.19	0.59		0.02	0.07	0.06	0.34
	UCI		1.71	1.63	1.93	1.25		0.87	3.42	6.80	1.90		5.33	6.15	8.86	2.16		2.47	4.73	10.28	2.27
	p value		0.51	0.48	0.68	0.73		**0.03**	0.58	0.81	0.68		0.81	0.89	0.80	0.72		0.21	0.61	0.87	0.80
75+	**Odds Ratio**	1	0.99	1.32	0.25	0.91	1			2.05	0.96	1	1.22			0.50	1				
	LCI		0.30	0.43	0.03	0.61				0.09	0.17		0.07			0.15					
	UCI		3.24	3.98	2.13	1.36				47.91	5.44		19.77			1.72					
	p value		0.99	0.63	0.20	0.64				0.65	0.96		0.89			0.27					

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p<0.05)

Appendix 24: Binary logistic regression of distance to alcohol outlets on frequent consumption of five or more alcoholic drinks by location.

		Urban					Rural				
		Distance to alcohol outlets									
	Distance	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**
Baseline	**Odds Ratio**	1	0.92	0.97	0.81	0.96	1	1.11	1.26	0.67	0.83
	LCI		0.77	0.81	0.62	0.90		0.55	0.66	0.41	0.71
	UCI		1.10	1.15	1.06	1.03		2.24	2.40	1.07	0.96
	p value		0.37	0.69	0.12	0.30		0.76	0.48	0.09	**0.01**
Model 1 Age and Gender	**Odds Ratio**	1	0.97	1.00	0.93	0.99	1	1.30	1.65	0.58	0.76
	LCI		0.80	0.83	0.71	0.92		0.50	0.78	0.32	0.63
	UCI		1.18	1.20	1.21	1.07		3.40	3.49	1.05	0.91
	p value		0.79	1.00	0.59	0.80		0.59	0.19	0.07	**0.00**
Model 2 Ethnicity	**Odds Ratio**	1	0.97	0.98	0.90	0.98	1	1.35	1.76	0.62	0.77
	LCI		0.80	0.81	0.69	0.91		0.50	0.82	0.34	0.64
	UCI		1.18	1.18	1.18	1.06		3.63	3.77	1.14	0.94
	p value		0.74	0.83	0.46	0.61		0.55	0.15	0.13	**0.01**
Model 3 Personal income	**Odds Ratio**	1	0.95	0.98	0.91	0.98	1	1.27	1.93	0.65	0.79
	LCI		0.78	0.81	0.69	0.91		0.45	0.86	0.35	0.65
	UCI		1.17	1.18	1.19	1.06		3.63	4.30	1.24	0.96
	p value		0.65	0.80	0.49	0.63		0.65	0.11	0.19	**0.02**
Model 4 Individual deprivation	**Odds Ratio**	1	0.95	0.98	0.92	0.99	1	1.27	1.92	0.66	0.79
	LCI		0.78	0.81	0.70	0.91		0.44	0.85	0.34	0.65
	UCI		1.16	1.19	1.21	1.07		3.65	4.34	1.26	0.97
	p value		0.62	0.87	0.57	0.74		0.66	0.12	0.21	**0.02**
Model 5 Area Deprivation	**Odds Ratio**	1	0.98	1.02	1.00	1.01	1	1.29	2.01	0.65	0.78
	LCI		0.80	0.84	0.75	0.93		0.43	0.85	0.31	0.63
	UCI		1.21	1.24	1.33	1.09		3.86	4.77	1.35	0.96
	p value		0.88	0.84	1.00	0.86		0.65	0.11	0.25	**0.02**

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

Appendix 25: Binary logistic regression of distance to alcohol outlets on frequent consumption of five drinks or more in urban/rural areas by gender while adjusting for a range of individual characteristics and contextual variables.

		Urban										Rural									
		Male					Female					Male					Female				
		Distance to alcohol outlets																			
	Distance	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**	**<571m**	**572-995m**	**996m-2.1km**	**>2.2km**	**Test of trends**
Baseline	**Odds Ratio**	1	0.86	0.91	0.73	0.94	1	1.05	1.00	1.04	1.00	1	0.98	2.24	1.03	0.97	1	1.35	0.77	**0.33**	0.62
	LCI		0.69	0.73	0.52	0.86		0.79	0.76	0.68	0.90		0.38	0.83	0.49	0.79		0.41	0.30	0.15	0.47
	UCI		1.07	1.13	1.03	1.03		1.41	1.33	1.57	1.12		2.50	6.04	2.17	1.20		4.48	1.95	0.73	0.81
	p value		0.18	0.38	0.08	0.16		0.73	0.98	0.87	0.96		0.96	0.11	0.94	0.78		0.62	0.58	**0.01**	**0.00**
Model 1 Age	**Odds Ratio**	1	0.90	0.96	0.81	0.97	1	1.08	1.03	1.07	1.01	1	0.97	3.05	0.97	0.94	1	1.22	0.69	**0.24**	0.55
	LCI		0.71	0.77	0.57	0.88		0.80	0.77	0.71	0.90		0.34	1.01	0.44	0.75		0.30	0.25	0.10	0.41
	UCI		1.13	1.20	1.16	1.06		1.46	1.39	1.59	1.14		2.77	9.26	2.16	1.17		4.89	1.92	0.59	0.74
	p value		0.37	0.74	0.25	0.48		0.61	0.84	0.75	0.81		0.95	**0.05**	0.95	0.56		0.78	0.48	**0.00**	**0.00**
Model 2 Ethnicity	**Odds Ratio**	1	0.90	0.95	0.79	0.96	1	1.04	0.99	1.04	1.00	1	0.95	**3.18**	1.00	0.95	1	1.31	0.72	**0.27**	0.57
	LCI		0.72	0.76	0.55	0.87		0.77	0.73	0.70	0.89		0.33	1.04	0.45	0.76		0.29	0.24	0.10	0.41
	UCI		1.14	1.19	1.12	1.05		1.41	1.34	1.56	1.13		2.71	9.70	2.21	1.18		5.89	2.15	0.72	0.78
	p value		0.39	0.67	0.19	0.38		0.79	0.95	0.84	0.98		0.92	**0.04**	1.00	0.62		0.73	0.55	**0.01**	**0.00**
Model 3 Personal Income	**Odds Ratio**	1	0.91	0.98	0.80	0.97	1	1.00	0.95	1.05	0.99	1	0.80	**3.72**	1.00	0.96	1	1.29	0.69	**0.29**	0.58
	LCI		0.72	0.78	0.56	0.88		0.73	0.70	0.70	0.88		0.25	1.14	0.42	0.76		0.26	0.19	0.09	0.41
	UCI		1.16	1.24	1.15	1.07		1.37	1.29	1.57	1.12		2.53	12.18	2.40	1.21		6.49	2.55	0.92	0.83
	p value		0.45	0.89	0.23	0.54		1.00	0.73	0.83	0.91		0.71	**0.03**	1.00	0.71		0.76	0.58	**0.04**	**0.00**
Model 4 Individual deprivation	**Odds Ratio**	1	0.91	0.98	0.80	0.97	1	0.97	0.96	1.10	1.01	1	0.81	**3.46**	1.00	0.96	1	1.21	0.68	**0.28**	0.58
	LCI		0.72	0.78	0.56	0.88		0.71	0.71	0.74	0.89		0.26	1.03	0.41	0.76		0.25	0.18	0.09	0.41
	UCI		1.15	1.24	1.15	1.07		1.33	1.31	1.64	1.14		2.55	11.67	2.41	1.22		5.93	2.50	0.89	0.83
	p value		0.43	0.88	0.24	0.54		0.87	0.80	0.65	0.90		0.72	**0.05**	0.99	0.75		0.82	0.56	**0.03**	**0.00**
Model 6 Area deprivation	**Odds Ratio**	1	0.94	0.99	0.84	0.98	1	1.01	1.04	1.24	1.05	1	0.90	**4.05**	1.11	0.97	1	1.08	0.58	**0.23**	0.55
	LCI		0.74	0.78	0.58	0.88		0.73	0.76	0.81	0.92		0.27	1.19	0.42	0.75		0.22	0.15	0.07	0.39
	UCI		1.20	1.26	1.23	1.08		1.38	1.43	1.91	1.19		3.02	13.79	2.90	1.27		5.31	2.34	0.76	0.77
	p value		0.63	0.96	0.38	0.68		0.97	0.80	0.32	0.45		0.86	**0.03**	0.83	0.85		0.93	0.45	**0.02**	**0.00**

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p <0.05)

Appendix 26: Binary logistic regression of density of alcohol outlets within 800 metres buffer on hazardous consumption of alcohol by gender and location while adjusting for a range of individual characteristics and contextual variables.

		Male					Female				
		Density of alcohol outlets within 800 metres buffer									
		No outlet	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.01	1.00	1.06	1.01	1	1.28	1.24	**1.82**	1.19
	LCI		0.81	0.80	0.82	0.94		0.97	0.93	1.25	1.06
	UCI		1.27	1.25	1.37	1.09		1.68	1.65	2.65	1.33
	p value		0.90	0.99	0.64	0.73		0.08	0.14	**0.00**	**0.00**
Model 1	**Odds Ratio**	1	0.96	0.90	0.92	0.96	1	1.27	1.17	**1.61**	1.14
Age	**LCI**		0.76	0.71	0.70	0.89		0.95	0.86	1.14	1.03
	UCI		1.20	1.13	1.20	1.05		1.70	1.59	2.26	1.27
	p value		0.72	0.37	0.54	0.39		0.11	0.32	**0.01**	**0.01**
Model 2	**Odds Ratio**	1	0.99	0.91	0.99	0.98	1	1.30	1.19	**1.73**	1.16
Ethnicity	**LCI**		0.79	0.72	0.75	0.91		0.97	0.87	1.21	1.04
	UCI		1.25	1.15	1.30	1.07		1.75	1.62	2.48	1.30
	p value		0.93	0.44	0.95	0.69		0.08	0.28	**0.00**	**0.01**
Model 3	**Odds Ratio**	1	0.99	0.90	0.98	0.98	1	1.33	1.24	**1.69**	1.16
Personal	**LCI**		0.78	0.71	0.74	0.90		0.98	0.91	1.17	1.04
income	**UCI**		1.25	1.15	1.30	1.07		1.80	1.70	2.43	1.30
	p value		0.92	0.40	0.89	0.62		0.06	0.18	**0.01**	**0.01**
Model 4	**Odds Ratio**	1	1.00	0.91	0.99	0.98	1	1.27	1.18	**1.60**	1.14
Individual	**LCI**		0.78	0.71	0.74	0.90		0.90	0.84	1.08	1.01
deprivation	**UCI**		1.27	1.18	1.33	1.08		1.80	1.65	2.35	1.28
	p value		1.00	0.49	0.97	0.73		0.17	0.34	**0.02**	**0.03**
Model 5	**Odds Ratio**	1	1.00	0.89	0.96	0.97	1	1.25	1.14	**1.46**	1.11
Urban/rural	**LCI**		0.78	0.69	0.72	0.89		0.89	0.81	1.00	0.99
	UCI		1.27	1.15	1.28	1.06		1.78	1.60	2.13	1.24
	p value		0.97	0.39	0.77	0.53		0.20	0.44	**0.05**	0.08
Model 6	**Odds Ratio**	1	1.00	0.88	0.94	0.96	1	1.24	1.13	1.41	1.10
Area	**LCI**		0.78	0.68	0.69	0.88		0.87	0.81	0.97	0.98
deprivation	**UCI**		1.28	1.14	1.27	1.06		1.76	1.59	2.05	1.23
	p value		0.99	0.34	0.68	0.44		0.23	0.48	0.07	0.11

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 27: Binary logistic regression density of alcohol outlets within 800 metres buffer on hazardous consumption of alcohol by gender and age group

		National									
		Male					Female				
		Density of alcohol outlets within 800 metres buffer									
		No outlet	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
15-24	**Odds Ratio**	1	1.36	1.02	0.84	0.94	1	1.40	1.04	2.60	1.29
	LCI		0.76	0.58	0.45	0.77		0.82	0.59	1.40	1.05
	UCI		2.44	1.79	1.59	1.14		2.41	1.84	4.82	1.58
	p value		0.31	0.95	0.60	0.53		0.22	0.88	0.00	0.01
25-34	**Odds Ratio**	1	**0.59**	0.78	**0.52**	0.84	1	0.94	1.25	1.53	1.16
	LCI		0.35	0.45	0.29	0.70		0.56	0.74	0.83	0.95
	UCI		0.99	1.35	0.95	1.01		1.59	2.10	2.83	1.40
	p value		**0.05**	0.37	**0.03**	0.07		0.83	0.40	0.17	0.14
35-44	**Odds Ratio**	1	0.85	0.65	1.09	0.96	1	1.17	1.28	0.81	1.01
	LCI		0.55	0.41	0.63	0.81		0.64	0.72	0.37	0.83
	UCI		1.31	1.02	1.87	1.13		2.12	2.29	1.79	1.24
	p value		0.46	0.06	0.76	0.60		0.61	0.40	0.61	0.89
45-54	**Odds Ratio**	1	0.93	0.90	1.26	1.03	1	1.74	1.22	0.91	1.02
	LCI		0.54	0.52	0.64	0.85		0.84	0.59	0.35	0.81
	UCI		1.60	1.58	2.47	1.27		3.62	2.51	2.35	1.29
	p value		0.79	0.72	0.50	0.74		0.14	0.60	0.85	0.85
55-64	**Odds Ratio**	1	1.03	1.10	1.32	1.08	1	1.25	0.93	0.24	0.79
	LCI		0.59	0.60	0.69	0.88		0.43	0.35	0.03	0.56
	UCI		1.79	2.01	2.54	1.32		3.66	2.53	1.94	1.12
	p value		0.92	0.76	0.40	0.46		0.68	0.89	0.18	0.18
65-74	**Odds Ratio**	1	1.19	1.46	1.79	1.21	1	3.28	2.86	1.15	1.15
	LCI		0.61	0.68	0.72	0.93		0.68	0.48	0.17	0.77
	UCI		2.31	3.13	4.45	1.59		15.71	17.07	8.01	1.73
	p value		0.61	0.34	0.21	0.16		0.14	0.25	0.89	0.50
75+	**Odds Ratio**	1	1.81	1.37	0.85	0.96	1	0.52	1.25	0.73	1.00
	LCI		0.51	0.34	0.17	0.65		0.07	0.18	0.09	0.52
	UCI		6.46	5.51	4.33	1.42		4.14	8.49	5.68	1.92
	p value		0.36	0.66	0.84	0.84		0.54	0.82	0.77	0.99

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 28: Binary logistic regression of density of alcohol outlets within 800 metres buffer on hazardous consumption by ethnicity while adjusting for a range of individual characteristics and contextual variables.

		European					Māori and Pacific Island Persons				
		Density of alcohol outlets within 800 metres buffer									
		No outlet	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
Baseline Model	**Odds Ratio**	1	1.17	1.13	**1.35**	1.09	1	1.02	1.02	**1.33**	1.07
	LCI		0.95	0.90	1.03	1.01		0.80	0.80	1.01	0.99
	UCI		1.45	1.42	1.79	1.18		1.30	1.30	1.75	1.17
	p value		0.14	0.29	**0.03**	**0.04**		0.89	0.88	**0.04**	0.11
Model 1 Age and Gender	**Odds Ratio**	1	1.15	1.07	1.22	1.05	1	0.96	0.91	**1.34**	1.06
	LCI		0.92	0.84	0.91	0.97		0.74	0.70	1.01	0.96
	UCI		1.44	1.36	1.62	1.15		1.23	1.19	1.79	1.16
	p value		0.22	0.58	0.19	0.22		0.73	0.49	**0.05**	0.24
Model 2 Personal income	**Odds Ratio**	1	1.16	1.07	1.20	1.05	1	0.97	0.94	1.28	1.05
	LCI		0.92	0.84	0.90	0.96		0.74	0.71	0.95	0.95
	UCI		1.45	1.36	1.61	1.14		1.26	1.23	1.73	1.15
	p value		0.21	0.60	0.22	0.26		0.80	0.65	0.11	0.33
Model 3 Individual deprivation	**Odds Ratio**	1	1.14	1.04	1.12	1.03	1	0.95	0.89	1.23	1.03
	LCI		0.91	0.82	0.84	0.95		0.73	0.67	0.91	0.94
	UCI		1.43	1.33	1.49	1.12		1.25	1.17	1.65	1.13
	p value		0.25	0.74	0.44	0.50		0.73	0.40	0.18	0.55
Model 4 Urban/rural	**Odds Ratio**	1	1.16	1.06	1.14	1.03	1	0.91	0.84	1.16	1.01
	LCI		0.91	0.82	0.84	0.94		0.69	0.63	0.85	0.92
	UCI		1.48	1.37	1.54	1.13		1.21	1.13	1.58	1.12
	p value		0.24	0.67	0.40	0.48		0.52	0.25	0.36	0.82
Model 5 Area Deprivation	**Odds Ratio**	1	1.17	1.06	1.14	1.03	1	0.87	0.80	1.09	0.99
	LCI		0.91	0.81	0.84	0.94		0.66	0.59	0.78	0.89
	UCI		1.50	1.38	1.55	1.13		1.16	1.08	1.50	1.10
	p value		0.21	0.68	0.40	0.50		0.34	0.14	0.62	0.85

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

Appendix 29: Binary logistic regression density of alcohol outlets within 800 metres buffer on hazardous consumption of alcohol by gender, ethnicity and age group

		European Male					Male Māori and Pacific Island persons					European Female					Female Māori and Pacific Island persons				
		Density of alcohol outlets within 800 metres buffer																			
	Distance	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
15-24	**Odds Ratio**	1	0.89	0.80	1.39	1.05	1	1.88	1.08	1.90	1.12	1	1.84	1.24	**4.83**	1.55	1	0.89	0.80	1.39	1.05
	LCI		0.49	0.44	0.65	0.84		0.86	0.50	0.75	0.84		0.80	0.51	1.94	1.16		0.49	0.44	0.65	0.84
	UCI		1.59	1.47	2.96	1.31		4.13	2.35	4.80	1.50		4.21	3.04	12.01	2.08		1.59	1.47	2.96	1.31
	p value		0.68	0.48	0.40	0.68		0.12	0.85	0.18	0.43		0.15	0.64	**0.00**	**0.00**		0.68	0.48	0.40	0.68
25-34	**Odds Ratio**	1	0.93	0.88	1.84	1.16	1	0.82	0.59	0.82	0.89	1	0.95	1.53	1.55	1.19	1	0.93	0.88	1.84	1.16
	LCI		0.52	0.45	0.81	0.89		0.37	0.28	0.33	0.67		0.44	0.74	0.62	0.90		0.52	0.45	0.81	0.89
	UCI		1.66	1.72	4.20	1.50		1.82	1.23	2.07	1.16		2.02	3.14	3.84	1.57		1.66	1.72	4.20	1.50
	p value		0.81	0.71	0.15	0.28		0.63	0.16	0.68	0.38		0.89	0.25	0.35	0.22		0.81	0.71	0.15	0.28
35-44	**Odds Ratio**	1	0.42	0.73	0.42	0.78	1	1.00	1.54	1.51	1.18	1	2.17	2.19	1.28	1.20	1	0.42	0.73	0.42	0.78
	LCI		0.20	0.37	0.16	0.59		0.53	0.79	0.71	0.94		0.91	0.89	0.39	0.91		0.20	0.37	0.16	0.59
	UCI		0.86	1.43	1.15	1.03		1.87	2.98	3.22	1.49		5.18	5.39	4.19	1.57		0.86	1.43	1.15	1.03
	p value		**0.02**	0.36	0.09	0.08		1.00	0.20	0.29	0.16		0.08	0.09	0.68	0.19		0.02	0.36	0.09	0.08
45-54	**Odds Ratio**	1	1.38	1.86	1.87	1.26	1	1.00	1.62	1.31	1.16	1	1.81	1.10	0.61	0.95	1	1.38	1.86	1.87	1.26
	LCI		0.47	0.67	0.50	0.86		0.36	0.64	0.48	0.85		0.77	0.45	0.16	0.72		0.47	0.67	0.50	0.86
	UCI		4.05	5.16	6.99	1.84		2.83	4.10	3.60	1.59		4.27	2.67	2.32	1.26		4.05	5.16	6.99	1.84
	p value		0.56	0.23	0.35	0.23		0.99	0.31	0.60	0.35		0.18	0.84	0.47	0.73		0.56	0.23	0.35	0.23
55-64	**Odds Ratio**	1	0.33	2.56		0.94	1	0.77	0.25	4.63	1.06	1	1.44	0.58	0.30	0.75	1	0.33	2.56		0.94
	LCI		0.05	0.58		0.56		0.22	0.04	0.75	0.59		0.45	0.14	0.04	0.49		0.05	0.58		0.56
	UCI		2.14	11.24		1.59		2.66	1.47	28.59	1.92		4.61	2.37	2.48	1.13		2.14	11.24		1.59
	p value		0.24	0.21		0.83		0.67	0.12	0.10	0.84		0.54	0.45	0.26	0.17		0.24	0.21		0.83
65-74	**Odds Ratio**	1	0.60	1.32		0.91	1	0.65	0.37	2.20	1.27	1	5.19	4.87	0.97	1.20	1	0.60		1.32	0.91
	LCI		0.07	0.10		0.28		0.10	0.08	0.39	0.67		0.59	0.48	0.06	0.78		0.07		0.10	0.28
	UCI		5.02	18.05		2.89		4.36	1.60	12.44	2.42		45.21	49.30	16.03	1.84		5.02		18.05	2.89
	p value		0.64	0.83		0.87		0.66	0.18	0.37	0.46		0.14	0.18	0.99	0.40		0.64		0.83	0.87
75+	**Odds Ratio**	1					1		0.54	8.48	1.53	1	0.52	1.26	0.74	1.00	1				
	LCI								0.02	0.33	0.30		0.07	0.19	0.10	0.52					
	UCI								12.35	218.38	7.83		4.11	8.51	5.64	1.92					
	p value								0.70	0.20	0.61		0.54	0.81	0.77	1.00					

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p <0.05)

Appendix 30: Binary logistic regression density of alcohol outlets within 800 metres buffer on hazardous consumption of alcohol by location while adjusting for a range of individual characteristics and contextual variables.

		Urban					Rural				
		Density of alcohol outlets within 800 metres buffer									
		No outlet	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
Baseline Model	**Odds Ratio**	1	1.06	1.03	1.23	1.06	1	1.14	0.91	**0.78**	0.99
	LCI		0.87	0.84	0.97	0.98		0.61	0.39	0.65	0.76
	UCI		1.28	1.26	1.55	1.13		2.14	2.10	0.93	1.30
	p value		0.56	0.77	0.09	0.14		0.67	0.83	**0.01**	0.96
Model 1 Age and Gender	**Odds Ratio**	1	1.01	0.95	1.10	1.02	1	1.32	1.08	1.01	1.10
	LCI		0.83	0.77	0.86	0.94		0.62	0.39	0.80	0.80
	UCI		1.23	1.17	1.39	1.09		2.83	2.97	1.28	1.52
	p value		0.91	0.63	0.46	0.68		0.48	0.88	0.93	0.56
Model 2 Ethnicity	**Odds Ratio**	1	1.05	0.97	1.19	1.04	1	1.30	1.00	0.95	1.07
	LCI		0.86	0.78	0.93	0.96		0.59	0.37	0.75	0.77
	UCI		1.28	1.19	1.51	1.12		2.84	2.69	1.20	1.49
	p value		0.64	0.75	0.17	0.34		0.51	0.99	0.67	0.69
Model 3 Personal income	**Odds Ratio**	1	1.05	0.97	1.17	1.03	1	1.27	1.22	**0.39**	1.07
	LCI		0.86	0.78	0.91	0.96		0.58	0.48	0.30	0.74
	UCI		1.29	1.20	1.50	1.11		2.79	3.13	0.50	1.53
	p value		0.60	0.79	0.22	0.42		0.55	0.68	**0.00**	0.73
Model 4 Individual deprivation	**Odds Ratio**	1	1.06	0.95	1.11	1.02	1	1.24	1.23	**0.43**	1.07
	LCI		0.87	0.77	0.88	0.94		0.53	0.49	0.31	0.74
	UCI		1.29	1.18	1.42	1.10		2.90	3.09	0.60	1.55
	p value		0.59	0.67	0.38	0.65		0.62	0.65	**0.00**	0.71
Model 5 Area Deprivation	**Odds Ratio**	1	1.06	0.95	1.08	1.01	1	1.20	1.30	**0.36**	1.06
	LCI		0.87	0.76	0.85	0.93		0.52	0.49	0.22	0.72
	UCI		1.30	1.17	1.38	1.09		2.79	3.46	0.60	1.56
	p value		0.57	0.61	0.52	0.85		0.67	0.60	**0.00**	0.78

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 31: Binary logistic regression of density of alcohol outlets within 800 metres buffer and hazardous consumption by location and age group.

		Urban					Rural				
		Density of alcohol outlets within 800 metres buffer									
Age group		**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
15-24	**Odds Ratio**	1	1.27	0.97	1.34	1.06	1	2.35	0.28	0.97	1.05
	LCI		0.82	0.63	0.82	0.91		0.54	0.03	0.57	0.67
	UCI		1.98	1.49	2.18	1.23		10.16	2.33	1.64	1.65
	p value		0.29	0.88	0.24	0.49		0.25	0.24	0.91	0.84
25-34	**Odds Ratio**	1	0.77	1.01	0.83	0.97	1	0.18	0.43		0.74
	LCI		0.51	0.66	0.54	0.85		0.05	0.09		0.32
	UCI		1.14	1.53	1.29	1.12		0.68	2.09		1.72
	p value		0.19	0.97	0.41	0.72		0.01	0.30		0.48
35-44	**Odds Ratio**	1	0.96	0.82	1.14	1.00	1	0.67	1.13		0.86
	LCI		0.65	0.56	0.72	0.87		0.26	0.35		0.51
	UCI		1.40	1.20	1.79	1.15		1.71	3.62		1.45
	p value		0.82	0.30	0.59	0.99		0.40	0.84		0.58
45-54	**Odds Ratio**	1	1.25	1.02	1.33	1.00	1	1.25	1.35		1.06
	LCI		0.76	0.63	0.74	0.87		0.30	0.32		0.57
	UCI		2.04	1.67	2.42	1.15		5.28	5.78		1.97
	p value		0.38	0.93	0.34	0.99		0.76	0.68		0.85
55-64	**Odds Ratio**	1	0.84	0.91	0.84	0.95	1	3.12	2.34		1.50
	LCI		0.48	0.52	0.45	0.78		0.99	0.24		0.72
	UCI		1.45	1.61	1.56	1.16		9.77	22.76		3.11
	p value		0.53	0.76	0.58	0.62		0.05	0.46		0.28
65-74	**Odds Ratio**	1	1.42	1.53	1.56	1.16	1	0.20			0.17
	LCI		0.77	0.76	0.67	0.91		0.04			0.04
	UCI		2.64	3.07	3.66	1.48		1.06			0.67
	p value		0.27	0.24	0.30	0.22		0.06			**0.01**
75+	**Odds Ratio**	1	0.84	0.71	0.51	0.81	1				
	LCI		0.27	0.22	0.14	0.55					
	UCI		2.63	2.25	1.83	1.19					
	p value		0.27	0.22	0.14	0.27					

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 32: Binary logistic regression of density of alcohol outlets within 800 metres buffer on hazardous consumption of alcohol by gender and location while adjusting for a range of individual characteristics and contextual variables.

		Urban										Rural									
		Male					Female					Male					Female				
		Density of alcohol outlets within 800 metres buffer																			
	Distance	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends
Baseline	**Odds Ratio**	1	1.06	1.04	1.09	1.02	1	1.06	1.05	**1.56**	1.13	1	0.71	0.59	0.87	0.77	1	2.74	2.12	**1.57**	1.50
	LCI		0.83	0.81	0.83	0.94		0.79	0.77	1.06	1.00		0.32	0.16	0.70	0.49		0.97	0.86	1.08	1.04
	UCI		1.36	1.33	1.43	1.11		1.42	1.43	2.31	1.29		1.56	2.22	1.09	1.21		7.72	5.26	2.27	2.16
	p value		0.64	0.76	0.52	0.57		0.70	0.76	**0.03**	**0.05**		0.39	0.43	0.23	0.26		0.06	0.10	**0.02**	**0.03**
Model 1	**Odds Ratio**	1	1.00	0.94	0.95	0.98	1	1.06	1.01	1.42	1.10	1	0.78	0.65	**0.65**	0.81	1	**3.58**	2.76	**1.73**	1.68
Age	**LCI**		0.78	0.73	0.71	0.89		0.78	0.73	0.98	0.98		0.34	0.15	0.47	0.51		1.19	0.98	1.08	1.09
	UCI		1.29	1.21	1.28	1.07		1.44	1.41	2.04	1.23		1.77	2.77	0.90	1.28		10.75	7.80	2.75	2.57
	p value		0.98	0.62	0.75	0.63		0.71	0.95	0.06	0.12		0.55	0.56	**0.01**	0.36		**0.02**	0.06	**0.02**	**0.02**
Model 2	**Odds Ratio**	1	1.04	0.95	1.03	1.00	1	1.09	1.03	**1.53**	1.12	1	0.77	0.64	**0.63**	0.8	1	3.52	2.16	1.6	1.59
Ethnicity	**LCI**		0.81	0.73	0.77	0.91		0.8	0.74	1.05	0.99		0.34	0.15	0.46	0.51		1.06	0.74	0.96	1.02
	UCI		1.34	1.23	1.38	1.09		1.48	1.44	2.24	1.27		1.76	2.69	0.84	1.27		11.68	6.37	2.65	2.47
	p value		0.77	0.7	0.83	0.96		0.58	0.85	**0.03**	0.06		0.54	0.54	**0.00**	0.34		**0.04**	0.16	0.07	**0.04**
Model 3	**Odds Ratio**	1	1.04	0.93	1.02	0.99	1	1.1	1.07	**1.49**	1.12	1	0.76	0.79	**0.68**	0.84	1	**3.68**	**2.83**		1.56
Personal	**LCI**		0.80	0.72	0.75	0.90		0.8	0.76	1.01	0.99		0.32	0.19	0.49	0.53		1.03	1.00		0.89
Income	**UCI**		1.34	1.22	1.37	1.09		1.51	1.5	2.18	1.26		1.8	3.34	0.95	1.34		13.09	7.98		2.74
	p value		0.79	0.62	0.91	0.85		0.55	0.69	**0.04**	0.08		0.53	0.75	**0.02**	0.46		**0.04**	**0.05**		0.12
Model 4	**Odds Ratio**	1	1.05	0.92	0.99	0.98	1	1.08	1.05	1.36	1.09	1	0.74	0.91	0.83	0.88	1	**3.80**	2.71		1.59
Individual	**LCI**		0.81	0.71	0.73	0.90		0.79	0.74	0.94	0.97		0.29	0.23	0.54	0.54		1.00	0.85		0.92
deprivation	**UCI**		1.36	1.20	1.34	1.08		1.49	1.47	1.97	1.22		1.89	3.61	1.28	1.41		14.41	8.58		2.75
	p value		0.74	0.56	0.94	0.70		0.62	0.80	0.10	0.16		0.53	0.89	0.40	0.59		**0.05**	0.09		0.10
Model 6	**Odds Ratio**	1	1.06	0.91	0.95	0.97	1	1.07	1.04	1.31	1.08	1	0.72	0.91	0.84	0.87	1	**3.75**	**4.91**		1.58
Area	**LCI**		0.81	0.70	0.70	0.88		0.78	0.74	0.91	0.96		0.27	0.22	0.44	0.52		1.16	0.99		0.83
deprivation	**UCI**		1.37	1.19	1.30	1.07		1.48	1.47	1.90	1.21		1.92	3.74	1.59	1.45		12.18	24.25		3.00
	p value		0.68	0.49	0.77	0.53		0.67	0.81	0.15	0.22		0.51	0.89	0.59	0.59		**0.03**	**0.05**		0.16

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p <0.05)

Appendix 33: Binary logistic regression of density of alcohol outlets within 800 metres buffer on frequent consumption of five or more drinks while adjusting for a range of individual characteristics and contextual variables.

		National				
		Walking distance to alcohol outlets (buffers of 800 metres)				
	Buffers	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	0.99	1.02	1.21	1.05
	LCI		0.84	0.86	0.98	0.99
	UCI		1.16	1.21	1.48	1.12
	p value		0.90	0.80	0.07	0.12
Model 1	**Odds Ratio**	1	0.95	0.95	1.11	1.02
Age and	**LCI**		0.80	0.80	0.90	0.96
Gender	**UCI**		1.13	1.14	1.37	1.09
	p value		0.57	0.59	0.33	0.55
Model 2	**Odds Ratio**	1	0.98	0.97	1.19	1.04
Ethnicity	**LCI**		0.82	0.81	0.97	0.98
	UCI		1.16	1.16	1.47	1.11
	p value		0.82	0.74	0.10	0.24
Model 3	**Odds Ratio**	1	0.99	0.95	1.15	1.03
Personal	**LCI**		0.83	0.79	0.92	0.96
income	**UCI**		1.18	1.13	1.44	1.09
	p value		0.90	0.54	0.21	0.45
Model 4	**Odds Ratio**	1	0.98	0.93	1.12	1.02
Individual	**LCI**		0.83	0.78	0.90	0.95
deprivation	**UCI**		1.17	1.12	1.40	1.08
	p value		0.84	0.44	0.30	0.61
Model 5	**Odds Ratio**	1	1.02	0.98	1.18	1.04
Urban/Rural	**LCI**		0.85	0.81	0.94	0.97
	UCI		1.23	1.18	1.48	1.11
	p value		0.81	0.80	0.16	0.32
Model 6	**Odds Ratio**	1	1.01	0.95	1.12	1.02
Area	**LCI**		0.84	0.79	0.89	0.95
Deprivation	**UCI**		1.22	1.15	1.41	1.09
	p value		0.90	0.62	0.32	0.57

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

Appendix 34: Binary logistic regression of density of alcohol outlets within 800 metres buffer on frequent consumption of five drinks or more by gender while adjusting for a range of individual characteristics and contextual variables

		Male					Female				
		Density of alcohol outlets within 800 metres buffer									
		No outlet	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	**1**	0.91	0.98	1.15	1.03	1	1.12	1.13	1.38	1.10
	LCI		0.74	0.79	0.90	0.96		0.87	0.87	0.98	0.99
	UCI		1.12	1.21	1.47	1.11		1.45	1.45	1.93	1.21
	p value		0.37	0.83	0.26	0.39		0.38	0.36	0.06	0.07
Model 1 Age	**Odds Ratio**	1	0.87	0.90	1.04	1.00	1	1.13	1.08	1.26	1.07
	LCI		0.71	0.72	0.81	0.92		0.86	0.83	0.90	0.97
	UCI		1.08	1.12	1.34	1.08		1.49	1.40	1.75	1.17
	p value		0.21	0.34	0.74	0.91		0.37	0.57	0.17	0.20
Model 2 Ethnicity	**Odds Ratio**	1	0.90	0.92	1.13	1.00	1	1.15	1.10	1.33	1.08
	LCI		0.73	0.74	0.88	0.92		0.87	0.84	0.96	0.98
	UCI		1.12	1.14	1.44	1.08		1.52	1.43	1.86	1.19
	p value		0.35	0.44	0.35	0.91		0.31	0.48	0.09	0.11
Model 3 Personal income	**Odds Ratio**	**1**	0.92	0.88	1.07	1.00	1	1.14	1.10	1.31	1.08
	LCI		0.74	0.70	0.83	0.92		0.86	0.84	0.93	0.98
	UCI		1.14	1.10	1.38	1.08		1.51	1.44	1.86	1.19
	p value		0.43	0.25	0.62	0.91		0.38	0.49	0.12	0.14
Model 4 Individual deprivation	**Odds Ratio**	**1**	0.91	0.87	1.05	0.99	1	1.11	1.07	1.22	1.06
	LCI		0.74	0.70	0.81	0.92		0.84	0.81	0.86	0.95
	UCI		1.13	1.09	1.36	1.07		1.48	1.40	1.72	1.17
	p value		0.41	0.22	0.70	0.83		0.46	0.65	0.26	0.30
Model 5 Urban/rural	**Odds Ratio**	1	0.96	0.92	1.12	1.02	1	1.16	1.11	1.27	1.07
	LCI		0.77	0.73	0.85	0.93		0.83	0.82	0.88	0.96
	UCI		1.20	1.16	1.46	1.10		1.61	1.51	1.84	1.20
	p value		0.71	0.48	0.42	0.72		0.39	0.50	0.21	0.23
Model 6 Area deprivation	**Odds Ratio**	1	0.97	0.90	1.09	1.01	1	1.12	1.08	1.16	1.04
	LCI		0.77	0.71	0.83	0.92		0.81	0.79	0.80	0.93
	UCI		1.21	1.14	1.43	1.09		1.55	1.46	1.68	1.16
	p value		0.76	0.40	0.54	0.89		0.50	0.64	0.45	0.47

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 35: Binary logistic regression of density of alcohol outlets within 800 metres buffer on frequent consumption of five drinks or more by gender and age

		Male					Female				
		Walking distance to alcohol outlets (buffers of 800 metres)									
		No outlet	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
15-24	**Odds Ratio**	1	0.93	1.24	1.15	1.07	1	1.12	0.96	1.33	1.07
	LCI		0.54	0.70	0.62	0.89		0.67	0.57	0.70	0.88
	UCI		1.58	2.20	2.15	1.30		1.88	1.62	2.52	1.30
	p value		0.78	0.47	0.66	0.47		0.67	0.88	0.38	0.51
25-34	**Odds Ratio**	1	**0.59**	0.58	0.57	0.82	1	1.09	1.34	1.07	1.06
	LCI		0.36	0.33	0.31	0.68		0.68	0.82	0.61	0.90
	UCI		0.98	1.03	1.04	1.00		1.74	2.21	1.89	1.25
	p value		**0.04**	0.06	0.07	**0.05**		0.72	0.24	0.82	0.50
35-44	**Odds Ratio**	1	0.92	0.78	1.25	1.01	1	1.39	1.07	1.03	1.02
	LCI		0.62	0.50	0.77	0.87		0.86	0.65	0.53	0.85
	UCI		1.38	1.20	2.04	1.18		2.25	1.76	1.99	1.21
	p value		0.69	0.26	0.37	0.86		0.17	0.80	0.92	0.86
45-54	**Odds Ratio**	1	0.85	1.01	0.90	0.98	1	0.68	1.09	1.35	1.09
	LCI		0.53	0.60	0.49	0.82		0.34	0.61	0.63	0.86
	UCI		1.37	1.71	1.66	1.17		1.37	1.94	2.92	1.38
	p value		0.51	0.97	0.75	0.82		0.28	0.78	0.44	0.49
55-64	**Odds Ratio**	1	1.18	0.94	1.68	1.11	1	1.90	0.94	1.84	1.14
	LCI		0.73	0.55	0.94	0.93		0.66	0.37	0.69	0.84
	UCI		1.91	1.60	3.01	1.33		5.42	2.40	4.92	1.53
	p value		0.50	0.82	0.08	0.25		0.23	0.90	0.22	0.40
65-74	**Odds Ratio**	1	0.72	1.07	1.55	1.12	1	0.81	0.61	1.27	0.99
	LCI		0.40	0.54	0.71	0.88		0.21	0.10	0.26	0.55
	UCI		1.30	2.11	3.39	1.44		3.18	3.50	6.30	1.79
	p value		0.27	0.86	0.27	0.36		0.76	0.57	0.77	0.97
75+	**Odds Ratio**	1	1.92	1.12	1.14	0.99	1				
	LCI		0.63	0.32	0.28	0.68					
	UCI		5.80	3.98	4.69	1.44					
	p value		0.25	0.86	0.85	0.97					

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 36: Binary logistic regression of density of alcohol outlets within 800 metres buffer on frequent consumption of five drinks or more by ethnicity, gender and age group

		European Male					Male Māori and Pacific Island persons					European Female					Female Māori and Pacific Island persons				
		Walking distance to alcohol outlets (buffers of 800 metres)																			
		No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends
15-24	**Odds Ratio**	1	1.01	1.31	0.98	1.03	1	0.93	1.73	**2.83**	1.38	1	1.05	0.82	1.59	1.11	1	1.20	1.27	1.42	1.12
	LCI		0.49	0.55	0.43	0.79		0.43	0.78	1.14	1.04		0.50	0.37	0.69	0.85		0.65	0.68	0.66	0.89
	UCI		2.05	3.09	2.23	1.33		2.01	3.80	7.03	1.82		2.21	1.83	3.69	1.46		2.21	2.39	3.07	1.41
	p value		0.99	0.54	0.96	0.84		0.86	0.18	**0.03**	**0.03**		0.90	0.62	0.28	0.44		0.56	0.46	0.37	0.33
25-34	**Odds Ratio**	1	0.60	0.67	0.52	0.82	1	0.93	0.50	1.14	0.92	1	1.15	1.54	0.89	1.04	1	1.03	1.17	1.99	1.22
	LCI		0.31	0.33	0.24	0.64		0.44	0.24	0.43	0.70		0.62	0.82	0.38	0.83		0.57	0.60	0.89	0.95
	UCI		1.15	1.37	1.15	1.05		1.95	1.04	2.98	1.20		2.13	2.91	2.10	1.30		1.85	2.30	4.43	1.56
	p value		0.13	0.28	0.11	0.11		0.85	0.06	0.80	0.53		0.66	0.18	0.79	0.75		0.93	0.64	0.09	0.12
35-44	**Odds Ratio**	1	0.91	0.67	1.28	0.99	1	1.47	1.42	2.08	1.24	1	1.71	1.18	0.98	1.03	1	0.87	1.09	1.16	1.05
	LCI		0.56	0.39	0.69	0.82		0.76	0.71	0.94	0.98		0.92	0.60	0.38	0.82		0.44	0.56	0.52	0.82
	UCI		1.50	1.14	2.37	1.19		2.81	2.82	4.64	1.58		3.19	2.32	2.55	1.29		1.70	2.15	2.62	1.35
	p value		0.72	0.14	0.43	0.90		0.25	0.32	0.07	0.07		0.09	0.62	0.98	0.81		0.67	0.79	0.71	0.69
45-54	**Odds Ratio**	1	0.86	1.06	0.82	0.97	1	1.14	1.17	1.61	1.14	1	0.85	0.89	1.18	1.01	1	**0.16**	2.10	1.63	1.36
	LCI		0.50	0.58	0.40	0.79		0.43	0.46	0.58	0.83		0.40	0.43	0.43	0.75		0.06	0.83	0.58	0.95
	UCI		1.49	1.95	1.65	1.18		3.01	2.98	4.48	1.56		1.82	1.85	3.24	1.36		0.43	5.29	4.58	1.95
	p value		0.60	0.85	0.57	0.74		0.79	0.74	0.36	0.43		0.68	0.76	0.75	0.94		**0.00**	0.12	0.36	0.09
55-64	**Odds Ratio**	1	1.27	1.01	1.71	1.13	1	0.70	0.38	5.24	1.05	1	2.37	0.84	2.13	1.16	1	0.20	1.08	0.47	0.89
	LCI		0.74	0.56	0.88	0.92		0.21	0.11	0.74	0.64		0.76	0.25	0.69	0.83		0.04	0.31	0.09	0.54
	UCI		2.16	1.82	3.32	1.38		2.29	1.27	37.08	1.73		7.42	2.80	6.58	1.62		1.15	3.80	2.37	1.46
	p value		0.38	0.97	0.11	0.24		0.55	0.12	0.10	0.84		0.14	0.78	0.19	0.39		0.07	0.91	0.36	0.63
65-74	**Odds Ratio**	1	0.77	1.11	1.32	1.08	1	0.15	0.54	2.71	1.48	1	0.86	0.78	1.35	1.04	1	1.02		1.04	0.82
	LCI		0.41	0.53	0.54	0.83		0.02	0.13	0.47	0.76		0.17	0.12	0.20	0.53		0.16		0.09	0.31
	UCI		1.42	2.31	3.27	1.42		0.93	2.16	15.65	2.91		4.32	5.01	9.21	2.04		6.69		12.63	2.19
	p value		0.40	0.78	0.54	0.57		0.04	0.38	0.27	0.25		0.85	0.79	0.76	0.91		0.98		0.98	0.69
75+	**Odds Ratio**	1	1.97	1.14	0.99	0.96	1		0.54	8.48	1.53										
	LCI		0.63	0.31	0.21	0.65			0.02	0.33	0.30										
	UCI		6.12	4.22	4.67	1.41			12.35	218.38	7.83										
	p value		0.24	0.84	0.99	0.83			0.70	0.20	0.61										

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 37: Binary logistic regression density of alcohol outlets within 800 metres buffer on frequent consumption of five or more drink by location while adjusting for a range of individual characteristics and contextual variables.

		Urban					Rural				
		Walking distance to alcohol outlets (buffers of 800 metres)									
		No outlet	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**	**No outlet**	**1-2 outlets**	**3-6 outlets**	**7+ outlets**	**Test of trends**
Baseline Model	**Odds Ratio**	**1**	0.95	0.98	1.18	1.05	**1**	1.29	1.73	1.13	1.23
	LCI		0.80	0.82	0.95	0.98		0.77	0.91	0.95	0.97
	UCI		1.14	1.18	1.47	1.12		2.17	3.29	1.35	1.55
	p value		0.61	0.86	0.13	0.20		0.34	0.10	0.16	0.08
Model 1 Age and Gender	**Odds Ratio**	**1**	0.92	0.92	1.10	1.02	**1**	1.53	2.33	**1.73**	1.43
	LCI		0.76	0.76	0.88	0.95		0.81	0.97	1.36	1.08
	UCI		1.11	1.11	1.37	1.09		2.91	5.57	2.20	1.91
	p value		0.37	0.39	0.43	0.63		0.19	0.06	**0.00**	**0.01**
Model 2 Ethnicity	**Odds Ratio**	**1**	0.94	0.93	1.17	1.04	**1**	1.49	2.20	**1.63**	1.40
	LCI		0.78	0.77	0.94	0.97		0.77	0.89	1.29	1.04
	UCI		1.13	1.13	1.46	1.11		2.89	5.40	2.05	1.88
	p value		0.53	0.48	0.17	0.33		0.24	0.09	**0.00**	**0.03**
Model 3 Personal income	**Odds Ratio**	**1**	0.96	0.93	1.15	1.03	**1**	1.46	1.97	1.12	1.32
	LCI		0.80	0.76	0.91	0.96		0.77	0.73	0.87	0.96
	UCI		1.16	1.12	1.45	1.10		2.79	5.32	1.44	1.83
	p value		0.71	0.44	0.25	0.48		0.25	0.18	0.39	0.09
Model 4 Individual deprivation	**Odds Ratio**	**1**	0.97	0.92	1.12	1.02	1	1.44	1.96	1.17	1.32
	LCI		0.80	0.76	0.89	0.95		0.74	0.73	0.87	0.95
	UCI		1.16	1.12	1.42	1.09		2.80	5.28	1.58	1.83
	p value		0.71	0.40	0.33	0.59		0.28	0.18	0.30	0.10
Model 5 Area Deprivation	**Odds Ratio**	**1**	0.96	0.90	1.07	1.00	1	1.46	2.08	1.05	1.32
	LCI		0.80	0.74	0.85	0.94		0.75	0.72	0.65	0.93
	UCI		1.16	1.10	1.35	1.08		2.83	5.99	1.69	1.88
	p value		0.69	0.31	0.56	0.91		0.27	0.17	0.84	0.12

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 38: Binary logistic regression of density of alcohol outlets within 800 metres buffer on frequent consumption of five drinks by location and gender while adjusting for a range of individual characteristics and contextual variables

		Urban										Rural									
		Male					Female					Male					Female				
		Distance to alcohol outlets																			
	Distance	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends	No outlet	1-2 outlets	3-6 outlets	7+ outlets	Test of trends
Baseline	**Odds Ratio**	1	0.96	1.02	1.19	1.05	1	0.95	0.96	1.24	1.06	1	0.78	1.10	**6.16**	1.05	1	2.75	3.59	0.92	1.63
	LCI		0.76	0.81	0.92	0.97		0.72	0.73	0.87	0.95		0.42	0.37	4.88	0.70		1.06	1.58	0.69	1.05
	UCI		1.20	1.28	1.54	1.14		1.25	1.27	1.76	1.18		1.43	3.28	7.78	1.55		7.10	8.16	1.22	2.52
	p value		0.69	0.89	0.18	0.21		0.70	0.79	0.24	0.33		0.42	0.86	**0.00**	0.83		**0.04**	**0.00**	0.56	**0.03**
Model 1 Age	**Odds Ratio**	1	0.91	0.93	1.08	1.02	1	0.95	0.93	1.14	1.03	1	0.86	1.31	**4.97**	1.12	1	**3.56**	**5.01**	1.11	1.89
	LCI		0.73	0.74	0.83	0.94		0.72	0.70	0.81	0.92		0.46	0.36	3.69	0.74		1.29	2.19	0.79	1.15
	UCI		1.15	1.18	1.41	1.10		1.26	1.24	1.62	1.15		1.63	4.73	6.68	1.69		9.85	11.45	1.56	3.11
	p value		0.45	0.56	0.55	0.69		0.75	0.62	0.45	0.60		0.65	0.68	**0.00**	0.60		**0.02**	**0.00**	0.56	**0.01**
Model 2 Ethnicity	**Odds Ratio**	1	0.94	0.94	1.16	1.03	1	0.97	0.95	1.21	1.05	1	0.85	1.27	**4.73**	1.10	1	**3.52**	**4.37**	1.05	1.82
	LCI		0.75	0.74	0.89	0.95		0.73	0.71	0.85	0.94		0.45	0.35	3.59	0.73		1.18	1.73	0.74	1.10
	UCI		1.19	1.19	1.51	1.12		1.29	1.26	1.72	1.17		1.60	4.59	6.23	1.66		10.53	11.06	1.50	3.01
	p value		0.61	0.63	0.26	0.42		0.83	0.72	0.28	0.41		0.61	0.71	**0.00**	0.65		**0.02**	**0.00**	0.78	**0.02**
Model 3 Personal Income	**Odds Ratio**	1	0.96	0.92	1.10	1.01	1	0.97	0.98	1.23	1.05	1	0.84	1.07	**5.22**	1.06	1	**3.38**	**4.36**		1.72
	LCI		0.76	0.72	0.84	0.93		0.73	0.73	0.85	0.94		0.43	0.23	3.80	0.66		1.13	1.53		0.96
	UCI		1.22	1.17	1.45	1.10		1.30	1.30	1.77	1.18		1.64	4.97	7.15	1.69		10.09	12.39		3.09
	p value		0.75	0.47	0.48	0.76		0.85	0.87	0.27	0.36		0.61	0.93	**0.00**	0.80		**0.03**	**0.01**		0.07
Model 4 Individual deprivation	**Odds Ratio**	1	0.97	0.92	1.10	1.01	1	0.96	0.96	1.14	1.03	1	0.81	1.13	**6.05**	1.07	1	**3.53**	**4.43**		1.71
	LCI		0.76	0.72	0.84	0.93		0.72	0.71	0.79	0.92		0.40	0.25	4.04	0.67		1.23	1.56		0.94
	UCI		1.23	1.17	1.44	1.10		1.29	1.28	1.64	1.15		1.61	5.08	9.05	1.72		10.13	12.56		3.11
	p value		0.79	0.48	0.49	0.78		0.80	0.76	0.48	0.59		0.54	0.87	**0.00**	0.77		**0.02**	**0.01**		0.08
Model 6 Area deprivation	**Odds Ratio**	1	0.99	0.91	1.08	1.00	1	0.93	0.93	1.04	1.00	1	0.79	1.06	**5.81**	1.06	1	**3.69**	**5.62**		1.72
	LCI		0.78	0.71	0.81	0.92		0.70	0.69	0.72	0.90		0.37	0.22	3.20	0.63		1.43	1.84		0.91
	UCI		1.26	1.15	1.42	1.09		1.25	1.25	1.50	1.12		1.68	5.09	10.54	1.77		9.55	17.19		3.25
	p value		0.92	0.42	0.61	0.95		0.64	0.64	0.85	0.94		0.54	0.94	**0.00**	0.84		**0.01**	**0.00**		0.10

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p <0.05)

Appendix 39: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on hazardous consumption while adjusting for a range of individual characteristics and contextual variables.

		National trends				
		Driving distance to alcohol outlets (Buffers of 3000 metres)				
		No outlet	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	**1**	1.13	1.09	**1.45**	1.13
	LCI		0.90	0.86	1.15	1.05
	UCI		1.43	1.37	1.84	1.21
	p value		0.29	0.48	**0.00**	**0.00**
Model 1 age and Gender	**Odds Ratio**	**1**	1.15	1.08	1.18	1.03
	LCI		0.90	0.85	0.92	0.96
	UCI		1.46	1.37	1.51	1.11
	p value		0.27	0.54	0.20	0.38
Model 2 Ethnicity	**Odds Ratio**	1	1.12	1.10	**1.30**	1.08
	LCI		0.87	0.85	1.00	1.00
	UCI		1.44	1.41	1.68	1.16
	p value		0.39	0.47	**0.05**	**0.05**
Model 3 Personal Income	**Odds Ratio**	1	1.14	1.10	**1.33**	1.08
	LCI		0.88	0.85	1.02	1.00
	UCI		1.48	1.41	1.73	1.17
	p value		0.31	0.47	**0.04**	**0.04**
Model 4Individual Deprivation	**Odds Ratio**	**1**	1.12	1.05	1.25	1.06
	LCI		0.86	0.81	0.96	0.98
	UCI		1.45	1.35	1.62	1.15
	p value		0.40	0.73	0.10	0.12
Model 5 Urban rural	**Odds Ratio**	1	1.22	1.16	1.39	1.09
	LCI		0.86	0.80	0.95	0.99
	UCI		1.72	1.70	2.04	1.19
	p value		0.27	0.43	0.09	0.08
Model 6 Area Deprivation	**Odds Ratio**	1	1.20	1.14	1.36	1.08
	LCI		0.84	0.78	0.92	0.98
	UCI		1.70	1.66	2.00	1.19
	p value		0.31	0.50	0.12	0.10

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (P= <0.05)

Appendix 40: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on hazardous consumption by gender while adjusting for a range of individual characteristics and contextual variables

		Male					Female				
		Density of alcohol outlets within 3000 metres buffer									
		No outlet	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	**1**	1.07	1.03	1.26	1.07	1	1.25	1.25	**1.86**	1.22
	LCI		0.79	0.77	0.93	0.98		0.81	0.81	1.19	1.08
	UCI		1.45	1.39	1.70	1.17		1.93	1.93	2.91	1.39
	p value		0.65	0.83	0.14	0.11		0.32	0.31	**0.01**	**0.00**
Model 1 Age	**Odds Ratio**	**1**	1.10	1.02	1.03	0.99	1	1.26	1.20	**1.55**	1.13
	LCI		0.80	0.76	0.76	0.91		0.81	0.78	1.00	1.00
	UCI		1.50	1.38	1.40	1.08		1.95	1.85	2.38	1.27
	p value		0.57	0.89	0.83	0.86		0.30	0.41	**0.05**	**0.05**
Model 2 Ethnicity	**Odds Ratio**	**1**	1.07	1.04	1.13	1.03	1	1.25	1.23	**1.74**	1.19
	LCI		0.77	0.76	0.82	0.94		0.80	0.80	1.12	1.05
	UCI		1.48	1.43	1.57	1.14		1.94	1.90	2.69	1.34
	p value		0.70	0.81	0.45	0.47		0.33	0.35	**0.01**	**0.01**
Model 3 Personal income	**Odds Ratio**	**1**	1.09	1.03	1.16	1.04	1	1.27	1.27	**1.80**	1.20
	LCI		0.79	0.75	0.83	0.94		0.80	0.81	1.15	1.06
	UCI		1.52	1.43	1.61	1.14		2.00	1.97	2.82	1.36
	p value		0.59	0.85	0.39	0.47		0.31	0.29	**0.01**	**0.01**
Model 4 Individual deprivation	**Odds Ratio**	1	1.09	1.00	1.11	1.02	1	1.18	1.15	**1.59**	1.16
	LCI		0.78	0.72	0.80	0.93		0.74	0.73	1.02	1.02
	UCI		1.53	1.39	1.56	1.12		1.87	1.79	2.50	1.32
	p value		0.60	0.99	0.53	0.69		0.49	0.55	**0.04**	**0.02**
Model 5 Urban/rural	**Odds Ratio**	1	1.33	1.28	1.42	1.06	1	1.09	1.04	1.44	1.16
	LCI		0.87	0.80	0.88	0.94		0.54	0.50	0.69	0.99
	UCI		2.04	2.04	2.29	1.19		2.20	2.15	3.02	1.35
	p value		0.19	0.31	0.15	0.32		0.82	0.92	0.33	0.06
Model 6 Area deprivation	**Odds Ratio**	1	1.28	1.23	1.37	1.06	1	1.09	1.04	1.42	1.15
	LCI		0.83	0.76	0.84	0.94		0.55	0.51	0.69	0.99
	UCI		1.99	1.99	2.24	1.19		2.18	2.12	2.93	1.34
	p value		0.26	0.39	0.21	0.36		0.80	0.92	0.34	0.08

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (P= <0.05)

Appendix 41: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on hazardous consumption of alcohol stratified by gender and age group

		Male					Female				
		Driving distance to alcohol outlets (buffers of 3000 metres)									
	Distance	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
15-24	**Odds Ratio**	1	0.78	0.88	0.91	1.02	1	1.22	1.26	2.06	1.30
	LCI		0.34	0.39	0.41	0.82		0.47	0.49	0.80	1.02
	UCI		1.80	1.97	2.01	1.27		3.16	3.27	5.31	1.64
	p value		0.56	0.75	0.81	0.85		0.68	0.63	0.13	**0.03**
25-34	**Odds Ratio**	1	0.85	0.76	0.69	0.89	1	1.35	1.34	1.75	1.17
	LCI		0.38	0.34	0.31	0.72		0.56	0.55	0.72	0.94
	UCI		1.93	1.68	1.51	1.10		3.29	3.30	4.24	1.45
	p value		0.70	0.50	0.35	0.28		0.51	0.52	0.22	0.15
35-44	**Odds Ratio**	1	1.11	0.95	0.96	0.96	1	1.62	1.46	1.50	1.05
	LCI		0.60	0.51	0.52	0.81		0.75	0.65	0.65	0.84
	UCI		2.06	1.75	1.79	1.14		3.50	3.32	3.48	1.32
	p value		0.75	0.86	0.91	0.65		0.22	0.36	0.35	0.64
45-54	**Odds Ratio**	1	0.74	0.78	0.79	0.96	1	1.12	1.08	0.61	0.86
	LCI		0.39	0.42	0.40	0.77		0.45	0.46	0.23	0.66
	UCI		1.41	1.45	1.55	1.19		2.78	2.50	1.61	1.11
	p value		0.36	0.43	0.49	0.69		0.81	0.86	0.32	0.25
55-64	**Odds Ratio**	1	**4.75**	**3.78**	**3.69**	1.13	1	0.95	0.44	0.50	0.73
	LCI		1.77	1.39	1.34	0.93		0.23	0.11	0.12	0.47
	UCI		12.72	10.29	10.16	1.39		3.82	1.74	2.00	1.12
	p value		**0.00**	**0.01**	**0.01**	0.22		0.94	0.24	0.32	0.14
65-74	**Odds Ratio**	1	1.06	1.04	1.62	1.17	1				
	LCI		0.37	0.36	0.53	0.85					
	UCI		3.06	3.01	4.91	1.63					
	p value		0.91	0.95	0.40	0.34					

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

Appendix 42: Binary logistic regression of driving distance to alcohol outlets on hazardous consumption of alcohol stratified by ethnicity, gender and age group

		European Male					Male Māori and Pacific Island persons					European Female					Female Māori and Pacific Island persons				
		Driving distance to alcohol outlets (buffers of 3000 metres)																			
	Distance	No outlet	1-13 outlets	14-37 outlets	38+ outlets	Test of trends	No outlet	1-13 outlets	14-37 outlets	38+ outlets	Test of trends	No outlet	1-13 outlets	14-37 outlets	38+ outlets	Test of trends	No outlet	1-13 outlets	14-37 outlets	38+ outlets	Test of trends
15-24	Odds Ratio	1	0.78	0.97	1.26	1.16	1	1.78	1.79	1.57	1.02	1	1.34	1.44	3.74	1.65	1	0.79	1.11	0.92	1.04
	LCI		0.27	0.34	0.48	0.87		0.46	0.47	0.41	0.73		0.31	0.33	0.89	1.13		0.30	0.43	0.34	0.81
	UCI		2.24	2.72	3.32	1.54		6.90	6.83	6.03	1.43		5.81	6.20	15.68	2.41		2.09	2.92	2.45	1.34
	p value		0.65	0.95	0.65	0.31		0.41	0.40	0.51	0.90		0.70	0.63	0.07	**0.01**		0.63	0.83	0.86	0.76
25-34	Odds Ratio	1	0.77	0.68	0.70	0.92	1	1.12	1.13	1.14	1.02	1	0.99	1.19	2.07	1.36	1	**2.64**	1.90	1.53	0.94
	LCI		0.29	0.26	0.28	0.71		0.34	0.35	0.35	0.74		0.30	0.36	0.64	0.98		1.00	0.71	0.56	0.73
	UCI		2.00	1.76	1.74	1.20		3.69	3.67	3.78	1.41		3.32	3.96	6.73	1.89		6.93	5.08	4.18	1.21
	p value		0.59	0.43	0.44	0.53		0.86	0.84	0.83	0.89		0.99	0.78	0.23	0.07		**0.05**	0.20	0.40	0.62
35-44	Odds Ratio	1	0.95	0.80	0.94	0.97	1	2.40	2.04	2.13	1.08	1	1.93	2.60	3.15	1.36	1	1.14	0.71	0.51	0.75
	LCI		0.46	0.39	0.46	0.78		0.88	0.74	0.75	0.83		0.53	0.71	0.88	0.98		0.39	0.23	0.16	0.55
	UCI		1.94	1.63	1.93	1.21		6.54	5.64	6.03	1.41		7.00	9.43	11.26	1.89		3.32	2.17	1.66	1.01
	p value		0.88	0.53	0.87	0.80		0.09	0.17	0.16	0.57		0.32	0.15	0.08	0.06		0.81	0.55	0.27	0.06
45-54	Odds Ratio	1	0.68	0.81	0.92	1.03	1	1.20	1.13	0.89	0.94	1	1.10	1.03	0.53	0.83	1	1.49	1.77	1.60	1.11
	LCI		0.32	0.40	0.42	0.79		0.41	0.41	0.29	0.67		0.39	0.40	0.17	0.62		0.26	0.30	0.23	0.71
	UCI		1.43	1.67	1.99	1.34		3.54	3.12	2.70	1.32		3.11	2.66	1.65	1.13		8.66	10.56	11.16	1.75
	p value		0.31	0.57	0.83	0.83		0.74	0.82	0.83	0.73		0.85	0.95	0.27	0.24		0.66	0.53	0.64	0.65
55-64	Odds Ratio	1	**4.93**	**4.08**	**4.15**	1.18	1	3.47	4.29	3.28	1.26	1	1.41	0.56	0.48	0.70	1	**0.07**	**0.13**	0.47	0.90
	LCI		1.57	1.28	1.27	0.93		0.48	0.58	0.38	0.76		0.24	0.09	0.07	0.43		0.01	0.02	0.07	0.32
	UCI		15.53	13.00	13.54	1.48		24.97	31.82	28.50	2.09		8.30	3.45	3.24	1.13		0.51	0.79	2.93	2.51
	p value		**0.01**	**0.02**	**0.02**	0.17		0.22	0.15	0.28	0.38		0.71	0.54	0.46	0.14		**0.01**	**0.03**	0.42	0.84
65-74	Odds Ratio	1	1.06	1.12	1.54	1.16	1	0.73	0.51	1.51	1.31	1					1				
	LCI		0.34	0.36	0.45	0.81		0.06	0.04	0.12	0.59										
	UCI		3.33	3.53	5.25	1.65		8.55	5.76	18.91	2.88										
	p value		0.92	0.84	0.49	0.42		0.80	0.58	0.75	0.51										
75+	Odds Ratio	1					1					1					1				
	LCI																				
	UCI																				
	p value																				

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 43: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on hazardous consumption by location while adjusting for a range of individual characteristics and contextual variables.

		Urban					Rural				
		Driving distance to alcohol outlets (buffers of 3000 metres)									
	Distance	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.19	1.12	1.49	**1.14**	1	1.03	0.93		1.02
	LCI		0.68	0.64	0.85	1.03		0.73	0.37		0.76
	UCI		2.07	1.94	2.60	1.25		1.46	2.37		1.37
	p value		0.55	0.70	0.16	**0.01**		0.86	0.88		0.91
Model 1 Age and Gender	**Odds Ratio**	1	1.06	1.01	1.10	1.03	1	1.30	1.34		1.26
	LCI		0.58	0.56	0.61	0.93		0.88	0.63		0.92
	UCI		1.93	1.84	2.00	1.13		1.90	2.87		1.73
	p value		0.85	0.97	0.75	0.61		0.18	0.45		0.15
Model 2 Ethnicity	**Odds Ratio**	1	1.07	1.06	1.26	1.09	1	1.27	1.38		1.24
	LCI		0.61	0.61	0.71	0.99		0.86	0.66		0.90
	UCI		1.89	1.87	2.22	1.20		1.87	2.87		1.72
	p value		0.82	0.83	0.43	0.08		0.24	0.39		0.18
Model 3 Personal income	**Odds Ratio**	1	1.07	1.05	1.27	1.09	1	1.34	1.21		1.29
	LCI		0.59	0.58	0.70	0.99		0.92	0.58		0.94
	UCI		1.93	1.90	2.30	1.21		1.96	2.49		1.76
	p value		0.84	0.87	0.44	0.07		0.13	0.61		0.12
Model 4 Individual deprivation	**Odds Ratio**	1	1.09	1.05	1.25	1.08	1	1.25	1.41		1.23
	LCI		0.58	0.56	0.67	0.98		0.83	0.68		0.88
	UCI		2.06	1.97	2.36	1.19		1.87	2.94		1.73
	p value		0.78	0.88	0.48	0.13		0.29	0.36		0.22
Model 5 Area Deprivation	**Odds Ratio**	1	1.07	1.03	1.22	1.07	1	1.32	1.60		1.31
	LCI		0.57	0.55	0.65	0.97		0.84	0.71		0.91
	UCI		1.99	1.91	2.27	1.18		2.08	3.59		1.88
	p value		0.83	0.93	0.54	0.16		0.22	0.26		0.15

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 44: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on hazardous consumption by location and gender while adjusting for a range of individual characteristics and contextual variables

		Urban										Rural									
		Male					Female					Male					Female				
		Density of alcohol outlets within 3000 metres buffer																			
	Distance	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.69	1.66	2.02	1.12	1	0.67	0.64	0.95	1.17	1	1.10	1.22		1.10	1	1.26	0.92		1.18
	LCI		0.70	0.69	0.84	1.00		0.28	0.27	0.40	0.99		0.70	0.73		0.76		0.62	0.26		0.67
	UCI		4.10	3.99	4.86	1.25		1.60	1.53	2.29	1.37		1.71	2.05		1.60		2.56	3.32		2.08
	p value		0.24	0.26	0.12	0.06		0.37	0.32	0.91	0.06		0.68	0.44		0.62		0.53	0.90		0.58
Model 1 Age	**Odds Ratio**	1	1.71	1.64	1.66	1.01	1	0.60	0.59	0.75	1.08	1	1.22	**1.58**		1.23	1	1.48	0.85		1.29
	LCI		0.64	0.62	0.63	0.90		0.30	0.29	0.37	0.93		0.77	1.01		0.84		0.73	0.19		0.74
	UCI		4.56	4.33	4.40	1.14		1.22	1.18	1.50	1.25		1.93	2.47		1.80		3.00	3.73		2.25
	p value		0.28	0.32	0.31	0.89		0.16	0.14	0.41	0.31		0.39	**0.05**		0.29		0.28	0.83		0.36
Model 2 Ethnicity	**Odds Ratio**	1	1.65	1.64	1.81	1.07	1	0.66	0.66	0.92	1.15	1	1.23	1.56		1.24	1	1.41	0.92		1.27
	LCI		0.62	0.63	0.69	0.95		0.33	0.34	0.47	0.99		0.78	0.99		0.85		0.67	0.22		0.71
	UCI		4.36	4.32	4.76	1.20		1.30	1.31	1.82	1.34		1.95	2.47		1.81		2.98	3.84		2.27
	p value		0.32	0.31	0.23	0.27		0.23	0.24	0.82	0.07		0.37	0.06		0.27		0.37	0.90		0.43
Model 3 Personal Income	**Odds Ratio**	1	1.71	1.66	1.88	1.07	1	0.61	0.63	0.87	1.16	1	1.35	**1.73**		1.34	1	1.43	0.27		1.21
	LCI		0.63	0.61	0.69	0.95		0.29	0.31	0.42	0.99		0.85	1.04		0.92		0.65	0.06		0.64
	UCI		4.68	4.50	5.09	1.21		1.26	1.31	1.81	1.36		2.15	2.88		1.97		3.15	1.28		2.31
	p value		0.29	0.32	0.22	0.27		0.18	0.22	0.71	0.07		0.20	**0.04**		0.13		0.37	0.10		0.56
Model 4 Individual deprivation	**Odds Ratio**	1	1.85	1.75	1.96	1.06	1	0.58	0.59	0.80	1.14	1	1.24	**1.89**		1.27	1	1.40	0.29		1.20
	LCI		0.65	0.62	0.70	0.94		0.26	0.27	0.36	0.97		0.75	1.01		0.84		0.62	0.06		0.63
	UCI		5.24	4.93	5.52	1.20		1.28	1.30	1.76	1.33		2.04	3.52		1.90		3.13	1.33		2.30
	p value		0.25	0.29	0.20	0.37		0.18	0.19	0.58	0.12		0.40	**0.05**		0.25		0.42	0.11		0.58
Model 6 Area deprivation	**Odds Ratio**	1	1.74	1.65	1.84	1.05	1	0.59	0.61	0.81	1.13	1	1.32	**2.29**		1.37	1	1.44	0.28		1.20
	LCI		0.61	0.59	0.65	0.93		0.27	0.28	0.37	0.96		0.72	1.16		0.86		0.70	0.05		0.68
	UCI		4.93	4.66	5.20	1.19		1.30	1.33	1.76	1.32		2.42	4.54		2.18		2.96	1.52		2.11
	p value		0.30	0.34	0.25	0.41		0.19	0.21	0.59	0.14		0.37	**0.02**		0.18		0.32	0.14		0.53

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (p<0.05)

Appendix 45: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of five or more drinks while adjusting for a range of individual characteristics and contextual variables.

		National				
		Driving distance (buffers of 3000 metres) to alcohol outlets				
	Buffers	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.11	1.00	1.24	1.06
	LCI		0.88	0.79	0.99	0.99
	UCI		1.38	1.25	1.57	1.13
	p value		0.38	0.97	0.06	0.08
Model 1	**Odds Ratio**	1	1.13	1.00	1.03	0.98
Age and	**LCI**		0.89	0.79	0.81	0.92
Gender	**UCI**		1.44	1.28	1.31	1.05
	p value		0.30	0.97	0.82	0.58
Model 2	**Odds Ratio**	1	1.13	1.04	1.14	1.02
Ethnicity	**LCI**		0.89	0.82	0.90	0.96
	UCI		1.43	1.32	1.45	1.09
	p value		0.31	0.75	0.29	0.53
Model 3	**Odds Ratio**	1	1.07	1.00	1.09	1.02
Personal	**LCI**		0.85	0.79	0.86	0.95
income	**UCI**		1.36	1.27	1.38	1.09
	p value		0.55	0.98	0.48	0.66
Model 4	**Odds Ratio**	1	1.06	0.98	1.06	1.01
Individual deprivation	**LCI**		0.84	0.77	0.84	0.94
	UCI		1.34	1.24	1.34	1.08
	p value		0.60	0.85	0.62	0.86
Model 5	**Odds Ratio**	1	1.31	1.27	1.38	1.06
Urban/Rural	**LCI**		0.95	0.90	0.97	0.97
	UCI		1.80	1.79	1.95	1.15
	p value		0.10	0.18	0.07	0.21
Model 6	**Odds Ratio**	1	1.27	1.22	1.31	1.04
Area	**LCI**		0.92	0.86	0.93	0.96
Deprivation	**UCI**		1.75	1.73	1.86	1.13
	p value		0.14	0.26	0.12	0.32

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 46: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of five or more drinks in by gender while adjusting for a range of individual characteristics and contextual variables

		Male					Female				
		Density of alcohol outlets within 3000 metres buffer									
		No outlet	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	**1**	0.94	0.88	1.11	1.05	1	**1.44**	1.29	**1.48**	1.07
	LCI		0.71	0.66	0.83	0.96		1.00	0.89	1.01	0.96
	UCI		1.26	1.17	1.48	1.14		2.10	1.86	2.17	1.19
	p value		0.70	0.38	0.50	0.27		**0.05**	0.18	**0.05**	0.21
Model 1	**Odds Ratio**	**1**	0.97	0.87	0.94	0.98	1	**1.52**	1.30	1.27	1.00
Age	**LCI**		0.72	0.65	0.70	0.90		1.02	0.88	0.86	0.90
	UCI		1.30	1.18	1.26	1.06		2.25	1.90	1.89	1.11
	p value		0.83	0.38	0.67	0.57		**0.04**	0.19	0.23	0.98
Model 2	**Odds Ratio**	**1**	0.96	0.91	1.04	1.02	1	**1.54**	1.35	1.41	1.04
Ethnicity	**LCI**		0.72	0.68	0.78	0.94		1.04	0.92	0.95	0.94
	UCI		1.29	1.22	1.39	1.11		2.29	1.98	2.10	1.16
	p value		0.80	0.52	0.79	0.67		**0.03**	0.13	0.09	0.47
Model 3	**Odds Ratio**	**1**	0.93	0.87	1.01	1.01	1	1.42	1.30	1.31	1.03
Personal	**LCI**		0.70	0.64	0.75	0.93		0.96	0.89	0.88	0.92
income	**UCI**		1.24	1.16	1.35	1.10		2.10	1.89	1.94	1.15
	p value		0.62	0.34	0.97	0.80		0.08	0.18	0.19	0.60
Model 4	**Odds Ratio**	1	0.93	0.86	1.00	1.01	1	1.36	1.22	1.20	1.01
Individual	**LCI**		0.69	0.64	0.74	0.93		0.91	0.83	0.81	0.90
deprivation	**UCI**		1.24	1.15	1.34	1.10		2.03	1.79	1.79	1.12
	p value		0.60	0.31	0.98	0.85		0.13	0.31	0.36	0.93
Model 5	**Odds Ratio**	1	0.93	0.86	1.00	1.01	1	1.63	1.55	1.53	1.01
Urban/rural	**LCI**		0.69	0.64	0.74	0.93		0.91	0.84	0.81	0.90
	UCI		1.24	1.15	1.34	1.10		2.93	2.86	2.88	1.12
	p value		0.60	0.31	0.98	0.85		0.10	0.16	0.19	0.93
Model 6	**Odds Ratio**	1	0.89	0.82	0.95	1.00	1	1.28	1.15	1.09	0.98
Area	**LCI**		0.67	0.61	0.71	0.92		0.86	0.78	0.73	0.88
deprivation	**UCI**		1.20	1.11	1.29	1.09		1.91	1.69	1.63	1.09
	p value		0.46	0.20	0.76	0.95		0.22	0.49	0.66	0.69

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 47: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of five or more drinks by gender and age group

		Male					Female				
		Density of alcohol outlets within 3000 metres buffer									
	Distance	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
15-24	**Odds Ratio**	1	0.87	0.86	1.05	1.06	1	1.65	1.79	1.75	1.11
	LCI		0.36	0.36	0.45	0.85		0.68	0.75	0.72	0.89
	UCI		2.12	2.08	2.45	1.31		3.99	4.28	4.23	1.38
	p value		0.76	0.74	0.92	0.62		0.27	0.19	0.22	0.36
25-34	**Odds Ratio**	1	0.83	0.69	0.67	0.89	1	1.99	1.53	1.80	1.07
	LCI		0.38	0.32	0.31	0.73		0.93	0.70	0.82	0.89
	UCI		1.82	1.49	1.42	1.08		4.29	3.35	3.94	1.29
	p value		0.64	0.35	0.29	0.24		0.08	0.28	0.14	0.47
35-44	**Odds Ratio**	1	0.99	0.83	0.97	0.98	1	1.96	1.10	1.25	0.92
	LCI		0.57	0.49	0.56	0.83		1.04	0.56	0.62	0.76
	UCI		1.74	1.43	1.66	1.15		3.71	2.17	2.49	1.11
	p value		0.98	0.51	0.90	0.78		0.04	0.78	0.53	0.40
45-54	**Odds Ratio**	1	0.67	0.72	0.59	0.88	1	0.99	0.96	0.58	0.85
	LCI		0.38	0.40	0.32	0.73		0.49	0.48	0.27	0.69
	UCI		1.20	1.28	1.07	1.06		2.00	1.92	1.25	1.06
	p value		0.18	0.27	0.08	0.17		0.97	0.91	0.17	0.15
55-64	**Odds Ratio**	1	1.84	1.58	1.90	1.12	1	0.82	0.85	0.57	0.86
	LCI		0.96	0.83	0.98	0.92		0.20	0.28	0.17	0.59
	UCI		3.51	3.02	3.70	1.35		3.32	2.58	1.99	1.25
	p value		0.06	0.16	0.06	0.25		0.78	0.78	0.38	0.44
65-74	**Odds Ratio**	1	1.00	0.91	1.09	1.02	1				
	LCI		0.44	0.39	0.44	0.77					
	UCI		2.28	2.09	2.75	1.34					
	p value		0.99	0.82	0.85	0.91					
75+	**Odds Ratio**	1					1				
	LCI										
	UCI										
	p value										

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p <0.05)

Appendix 48: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of alcohol by ethnicity while adjusting for a range of individual characteristics and contextual variables.

		European					Māori and Pacific Island Persons				
		Density of alcohol outlets within 3000 metres buffer									
		No outlet	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
Baseline Model	**Odds Ratio**	1	1.05	0.95	1.28	1.08	1	1.27	1.28	1.38	1.07
	LCI		0.82	0.73	0.99	1.00		0.89	0.90	0.96	0.97
	UCI		1.36	1.24	1.66	1.17		1.82	1.82	1.98	1.19
	p value		0.69	0.71	0.06	**0.05**		0.19	0.17	0.09	0.17
Model 1 Age and Gender	**Odds Ratio**	1	1.12	1.02	1.11	1.01	1	1.18	1.13	1.15	1.02
	LCI		0.86	0.78	0.85	0.94		0.79	0.76	0.77	0.91
	UCI		1.46	1.34	1.44	1.09		1.75	1.66	1.72	1.13
	p value		0.41	0.88	0.46	0.74		0.42	0.55	0.50	0.77
Model 2 Personal income	**Odds Ratio**	1	1.06	0.97	1.05	1.00	1	1.13	1.11	1.11	1.01
	LCI		0.81	0.74	0.81	0.93		0.76	0.74	0.74	0.91
	UCI		1.38	1.27	1.37	1.09		1.70	1.64	1.68	1.13
	p value		0.67	0.84	0.71	0.93		0.54	0.62	0.61	0.82
Model 3 Individual deprivation	**Odds Ratio**	1	1.05	0.96	1.02	0.99	1	1.12	1.08	1.09	1.00
	LCI		0.81	0.73	0.79	0.92		0.75	0.73	0.72	0.90
	UCI		1.37	1.25	1.33	1.07		1.68	1.61	1.64	1.12
	p value		0.70	0.74	0.86	0.88		0.58	0.70	0.70	0.93
Model 4 Urban/rural	**Odds Ratio**	1	1.35	1.32	1.41	1.06	1	1.13	1.09	1.09	1.00
	LCI		0.93	0.88	0.94	0.96		0.69	0.63	0.63	0.87
	UCI		1.96	1.98	2.13	1.17		1.85	1.88	1.91	1.14
	p value		0.11	0.19	0.10	0.28		0.63	0.76	0.75	0.97
Model 5 Area Deprivation	**Odds Ratio**	1	1.32	1.28	1.36	1.05	1	1.08	1.03	1.02	0.98
	LCI		0.91	0.85	0.90	0.95		0.65	0.60	0.58	0.86
	UCI		1.91	1.93	2.05	1.15		1.77	1.77	1.79	1.13
	p value		0.15	0.25	0.15	0.38		0.77	0.92	0.94	0.81

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

Appendix 49: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of alcohol stratified by ethnicity, gender and age group

		European Male					Male Māori and Pacific Island persons					European Female					Female Māori and Pacific Island persons				
		Density of alcohol outlets within 3000 metres buffer																			
	Distance	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
15-24	**Odds Ratio**	1	0.61	0.63	0.83	1.04	1	1.83	1.76	2.23	1.17	1	2.02	2.60	2.98	1.31	1	0.97	1.14	0.87	0.96
	LCI		0.22	0.22	0.32	0.79		0.49	0.48	0.60	0.85		0.51	0.68	0.77	0.97		0.37	0.44	0.33	0.74
	UCI		1.69	1.77	2.17	1.37		6.84	6.51	8.23	1.61		7.97	10.00	11.52	1.78		2.55	2.95	2.30	1.24
	p value		0.34	0.38	0.71	0.77		0.37	0.40	0.23	0.34		0.31	0.16	0.11	0.08		0.96	0.79	0.78	0.75
25-34	**Odds Ratio**	1	0.81	0.62	0.67	0.89	1	0.95	1.26	1.17	1.09	1	1.82	1.43	2.00	1.15	1	**3.30**	2.12	1.98	0.98
	LCI		0.32	0.25	0.28	0.70		0.29	0.39	0.36	0.80		0.68	0.52	0.73	0.89		1.31	0.86	0.80	0.76
	UCI		2.04	1.55	1.57	1.14		3.06	4.02	3.78	1.49		4.89	3.94	5.50	1.49		8.30	5.21	4.87	1.25
	p value		0.66	0.31	0.36	0.36		0.93	0.70	0.79	0.58		0.23	0.48	0.18	0.28		**0.01**	0.10	0.14	0.86
35-44	**Odds Ratio**	1	0.86	0.76	1.04	1.02	1	2.16	1.56	1.36	0.93	1	**2.54**	1.41	1.66	0.98	1	1.04	0.68	0.84	0.89
	LCI		0.45	0.41	0.56	0.84		0.77	0.57	0.48	0.70		1.05	0.55	0.65	0.77		0.38	0.24	0.28	0.66
	UCI		1.63	1.40	1.93	1.24		6.07	4.32	3.87	1.23		6.15	3.57	4.25	1.24		2.88	1.96	2.46	1.19
	p value		0.65	0.38	0.90	0.82		0.14	0.39	0.56	0.60		**0.04**	0.47	0.29	0.85		0.93	0.48	0.75	0.42
45-54	**Odds Ratio**	1	0.68	0.82	0.64	0.92	1	0.83	1.01	0.90	1.01	1	1.09	1.00	0.51	0.82	1	0.62	0.88	1.03	1.13
	LCI		0.36	0.43	0.33	0.74		0.27	0.35	0.30	0.71		0.48	0.44	0.20	0.64		0.19	0.26	0.26	0.73
	UCI		1.28	1.55	1.26	1.13		2.53	2.91	2.70	1.42		2.46	2.26	1.28	1.05		2.03	2.98	4.11	1.76
	p value		0.23	0.54	0.20	0.41		0.75	0.99	0.86	0.97		0.84	1.00	0.15	0.12		0.43	0.83	0.97	0.58
55-64	**Odds Ratio**	1	**2.18**	1.83	**2.27**	1.15	1	0.91	1.05	1.29	1.12	1	1.06	1.17	0.56	0.86	1	0.16	0.08	0.43	0.80
	LCI		1.01	0.86	1.03	0.93		0.24	0.27	0.29	0.69		0.20	0.30	0.11	0.57		0.03	0.01	0.08	0.35
	UCI		4.70	3.91	5.04	1.43		3.49	4.05	5.68	1.80		5.60	4.56	2.84	1.31		0.87	0.44	2.29	1.82
	p value		**0.05**	0.12	**0.04**	0.20		0.90	0.95	0.74	0.65		0.94	0.82	0.49	0.49		**0.03**	**0.00**	0.33	0.59
65-74	**Odds Ratio**	1	1.05	0.92	1.15	1.02	1	0.49	1.19	1.14	1.31	1					1				
	LCI		0.44	0.38	0.43	0.76		0.04	0.10	0.08	0.59										
	UCI		2.48	2.21	3.09	1.37		5.64	13.47	15.54	2.89										
	p value		0.92	0.85	0.78	0.89		0.56	0.89	0.92	0.50										
75+	**Odds Ratio**	1					1					1					1				
	LCI																				
	UCI																				
	p value																				

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

Appendix 50: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of five or more drinks by location while adjusting for a range of individual characteristics and contextual variables.

		Urban					Rural				
		Density of alcohol outlets within 3000 metres buffer									
	Distance	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.14	1.03	1.30	1.08	1	1.15	1.79		1.19
	LCI		0.69	0.62	0.78	0.99		0.83	0.88		0.90
	UCI		1.88	1.70	2.14	1.17		1.59	3.62		1.58
	p value		0.61	0.91	0.31	0.07		0.40	0.11		0.21
Model 1	**Odds Ratio**	1	1.03	0.95	0.98	0.98	1	**1.45**	**2.81**		1.51
Age and	**LCI**		0.65	0.60	0.62	0.90		1.01	1.56		1.12
Gender	**UCI**		1.63	1.51	1.55	1.06		2.10	5.07		2.04
	p value		0.90	0.84	0.92	0.61		**0.05**	**0.00**		**0.01**
Model 2	**Odds Ratio**	1	1.05	1.01	1.10	1.03	1	1.42	**2.89**		1.49
Ethnicity	**LCI**		0.68	0.65	0.71	0.95		0.98	1.60		1.09
	UCI		1.64	1.57	1.72	1.12		2.06	5.25		2.02
	p value		0.82	0.98	0.66	0.51		0.07	**0.00**		**0.01**
Model 3	**Odds Ratio**	1	1.02	0.99	1.08	1.03	1	1.39	**2.77**		1.46
Personal	**LCI**		0.64	0.62	0.68	0.95		0.96	1.36		1.07
income	**UCI**		1.61	1.57	1.71	1.12		2.02	5.67		1.98
	p value		0.94	0.97	0.74	0.47		0.08	**0.01**		**0.02**
Model 4	**Odds Ratio**	1	1.03	1.00	1.08	1.02	1	1.38	**2.83**		1.45
Individual	**LCI**		0.64	0.62	0.67	0.94		0.94	1.37		1.05
deprivation	**UCI**		1.67	1.61	1.74	1.12		2.01	5.84		1.98
	p value		0.89	0.98	0.75	0.57		0.10	**0.01**		**0.02**
Model 5	**Odds Ratio**	1	1.00	0.96	1.03	1.01	1	1.42	**2.81**		1.49
Area	**LCI**		0.63	0.60	0.64	0.93		0.96	1.29		1.09
Deprivation	**UCI**		1.60	1.53	1.64	1.10		2.10	6.15		2.04
	p value		1.00	0.86	0.92	0.76		0.08	**0.01**		**0.01**

LCI =Lower Confidence Interval

UCI=Upper Confidence Interval

Bold figures indicate statistically significant associations (p<0.05)

Appendix 51: Binary logistic regression of density of alcohol outlets within 3000 metres buffer on frequent consumption of five or more drinks by location and gender while adjusting for a range of individual characteristics and contextual variables

		Urban										Rural									
		Male					Female					Male					Female				
		Density of alcohol outlets within 3000 metres buffer																			
	Distance	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**	**No outlet**	**1-13 outlets**	**14-37 outlets**	**38+ outlets**	**Test of trends**
Baseline	**Odds Ratio**	1	1.17	1.13	1.43	1.11	1	0.91	0.81	0.94	1.01	1	1.10	1.54		1.13	1	1.66	3.28		1.71
	LCI		0.63	0.61	0.77	1.01		0.40	0.35	0.41	0.88		0.71	0.62		0.77		0.92	1.40		1.09
	UCI		2.18	2.09	2.65	1.23		2.09	1.85	2.16	1.16		1.69	3.80		1.64		2.98	7.72		2.67
	p value		0.62	0.70	0.26	0.04		0.83	0.62	0.88	0.85		0.67	0.35		0.53		0.09	0.01		0.02
Model 1 Age	**Odds Ratio**	1	1.19	1.12	1.21	1.02	1	0.88	0.79	0.78	0.94	1	1.24	2.22		1.28	1	1.92	3.29		1.88
	LCI		0.65	0.61	0.66	0.92		0.44	0.40	0.39	0.82		0.79	1.06		0.87		1.04	1.14		1.18
	UCI		2.19	2.06	2.22	1.12		1.78	1.59	1.57	1.07		1.95	4.64		1.90		3.53	9.55		2.99
	p value		0.58	0.71	0.54	0.74		0.73	0.52	0.49	0.33		0.36	0.04		0.21		0.04	0.03		0.01
Model 2 Ethnicity	**Odds Ratio**	1	1.17	1.15	1.32	1.07	1	0.97	0.89	0.93	0.98	1	1.20	2.29		1.26	1	1.89	3.59		1.89
	LCI		0.63	0.63	0.72	0.97		0.49	0.46	0.47	0.86		0.76	1.04		0.85		1.01	1.23		1.18
	UCI		2.17	2.13	2.44	1.18		1.89	1.73	1.83	1.12		1.88	5.04		1.86		3.55	10.45		3.04
	p value		0.61	0.65	0.37	0.19		0.92	0.73	0.84	0.80		0.43	0.04		0.26		0.05	0.02		0.01
Model 3 Personal Income	**Odds Ratio**	1	1.14	1.10	1.28	1.07	1	0.92	0.90	0.90	0.99	1	1.22	2.34		1.28	1	1.79	3.23		1.79
	LCI		0.62	0.60	0.70	0.96		0.46	0.45	0.45	0.86		0.76	1.23		0.85		0.95	0.88		1.09
	UCI		2.09	2.02	2.35	1.18		1.84	1.79	1.81	1.13		1.96	4.45		1.91		3.38	11.93		2.96
	p value		0.68	0.75	0.42	0.21		0.81	0.77	0.77	0.83		0.41	0.01		0.24		0.07	0.08		0.02
Model 4 Individual deprivation	**Odds Ratio**	1	1.16	1.13	1.31	1.07	1	0.89	0.86	0.84	0.97	1	1.17	2.44		1.24	1	1.82	2.96		1.79
	LCI		0.62	0.60	0.70	0.97		0.43	0.41	0.40	0.84		0.72	1.28		0.82		0.96	0.82		1.09
	UCI		2.19	2.12	2.48	1.19		1.86	1.79	1.77	1.11		1.89	4.66		1.87		3.46	10.73		2.93
	p value		0.65	0.71	0.40	0.19		0.76	0.69	0.66	0.64		0.53	0.01		0.30		0.07	0.10		0.02
Model 6 Area deprivation	**Odds Ratio**	1	1.09	1.05	1.22	1.06	1	0.86	0.83	0.78	0.95	1	1.21	2.56		1.30	1	1.81	2.86		1.77
	LCI		0.57	0.55	0.64	0.96		0.40	0.39	0.36	0.82		0.70	1.27		0.84		1.02	0.70		1.12
	UCI		2.06	1.99	2.31	1.18		1.83	1.76	1.67	1.08		2.08	5.17		2.00		3.21	11.64		2.78
	p value		0.79	0.88	0.54	0.25		0.70	0.62	0.52	0.42		0.49	0.01		0.24		0.04	0.14		0.01

LCI =Lower Confidence Interval
UCI=Upper Confidence Interval
Bold figures indicate statistically significant associations (P= <0.05)

Appendix 52: Simple correlation between hospitalisation rates and the density of alcohol outlets and confounding variables.

		Alcohol outlets						Control variables				
	Standardised rates of Hospitalisation	**All outlets**	**On-licenses**	**Off-licenses**	**Supermarkets/ general stores/dairies**	**Bottle stores**	**Hotel/Taverns/Bar**	**NZ deprivation**	**% Single parent**	**% 15-24**	**% males 15+**	**% 65 years**
All outlets	0.34**											
On-licenses	0.39**	0.90**										
Off-licenses	0.03**	0.10**	0.77**									
Supermarkets/ general stores/dairies	0.27**	0.68**	0.62**	0.73**								
Bottle stores	0.29**	0.66**	0.53**	0.74**	0.39**							
Hotel/taverns/bars	0.37**	0.94**	0.97**	0.87**	0.62**	0.55**						
NZ deprivation	0.31**	0.14**	0.14**	0.15**	0.13**	0.10**	0.15**					
% Single parent	0.38**	0.03	0.04	0.06**	0.04	0.12**	0.03	0.59**				
% 15-24	0.25**	0.05*	0.10**	-0.01	-0.01	0.10**	0.05*	0.18**	0.21**			
% males 15+	-0.07**	0.17**	0.14**	0.19**	0.05	0.10**	0.18**	-0.07**	-0.26**	-0.04		
% 65 years and over	0.12**	0.01*	0.07**	0.11**	0.14**	0.05*	0.08**	0.09**	0.02	-0.21**	-0.45**	
% Māori pop	0.17**	0.00	-0.01	0.03	0.06**	-0.03	0.01	0.46**	0.62**	-0.01	0.03	-0.15**

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Appendix 53: Correlation between hospitalisation rates and the density of alcohol outlets and confounding variables in urban areas

	Alcohol outlets							Control variables				
	Standardised rates of Hospitalisation	**All outlets**	**On-licenses**	**Off-licenses**	**Supermarkets/ general stores/dairies**	**Bottle stores**	**Hotel/Taverns/Bar**	**NZ deprivation**	**% Single parent**	**% 15-24**	**% Males 15+**	**% 65 years & over**
All outlets	0.38**											
On-licenses	0.44**	0.90**										
Off-licenses	0.35**	0.93**	0.77**									
Supermarkets/ general stores/dairies	0.34**	0.82**	0.77**	0.80**								
Bottle stores	0.31**	0.74**	0.59**	0.87**	0.53**							
Hotel/Taverns/Bars	0.43**	0.95**	0.98**	0.86**	0.79**	0.65**						
NZ deprivation	0.33**	0.12**	0.13**	0.12**	0.10**	0.11**	0.13**					
%Single parent	0.36**	0.05	0.06*	0.08**	0.04	0.11**	0.06*	0.60**				
% 15-24	0.26**	0.12*	0.17**	0.07*	0.07*	0.09**	0.14**	0.21**	0.17**			
% males 15+	0.08**	0.25**	0.16**	.027**	0.11**	0.23**	0.21**	-0.10**	-0.17**	0.09**		
% 65 and over years	0.05	0.04	0.05	0.07*	0.10**	0.01	0.06*	0.08**	-0.07*	-0.27**	-0.46**	
% Māori pop	0.18**	-0.01	-0.01	-0.01	0.01	-0.04	-0.01	0.42**	0.65**	-0.01	0.01	-0.17**

**Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Appendix 54: Correlation between hospitalisation rates and the density of alcohol outlets and confounding variables in rural areas.

		Alcohol outlets						Control variables				
	Standardised rates of Hospitalisation	**All outlets**	**On-licenses**	**Off-licenses**	**Supermarket/ general stores/dairies**	**Bottle stores**	**Hotel/Taverns/Bars**	**NZ deprivation**	**% Single parent**	**% 15-24**	**% Males 15+**	**% 65 years**
All outlets	0.24**											
On-licenses	0.22**	0.92**										
Off-licenses	0.36**	0.89**	0.81**									
Supermarkets / general stores/dairies	0.22**	0.40**	0.28**	0.61**								
Bottle stores	0.08	0.05	0.01	0.14**	0.08							
Hotel/Taverns/Bars	0.25**	0.94**	0.97**	0.89**	0.27**	-0.01						
NZ deprivation	0.27**	0.22**	0.22**	0.26**	0.21**	0.04	0.23**					
%Single parent	0.36**	0.07	0.06	0.17**	0.16**	0.11*	0.09	0.61**				
% 15-24	-0.02	-0.20**	-0.22**	-0.22**	-0.08	-0.09	-0.23**	0.03	0.04			
% males 15+	-0.18**	-0.05	-0.01	-0.13**	-0.20**	-0.13**	-0.02	-0.02	-0.18**	0.15**		
% 65 years and over	0.27**	0.28**	0.24**	0.40**	0.37**	0.26**	0.26**	0.17**	0.12*	-0.45**	-0.28**	
% Māori pop	0.25**	0.01	-0.02	0.06	0.11*	0.11*	-0.01	0.59**	0.77**	0.17**	-0.09	-0.06

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Appendix 55: Results for collinearity tests amongst variables with shaded areas showing evidence of collinearity

Component	Eigen value	Condition index	constant	Single parents	Area deprivation	% 65+	% 15-24	% Māori	% adult male
Constant	6.078	1.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Single parents	0.417	3.818	0.00	0.02	0.01	0.08	0.01	0.27	0.00
NZ deprivation	0.225	5.200	0.00	0.00	0.00	0.30	0.31	0.03	0.00
% 65+	0.127	6.909	0.00	0.11	0.34	0.00	0.01	0.30	0.00
% 15-24	0.086	8.386	0.00	0.25	0.56	0.14	0.19	0.01	0.00
% Māori	0.065	9.693	0.00	0.51	0.06	0.21	0.45	0.38	0.01
% adult male	0.002	61.381	0.99	0.11	0.02	0.26	0.03	0.01	0.99

Appendix 56: Simple correlation between serious violent crime rates and the density of alcohol outlets and confounding variables.

	Places where crime is occurring					Alcohol outlets						Control variables				
	Dwelling	**Licensed Premises**	**Public/ Roads**	**Other rates**	**Total rates**	**Total outlets**	**Off-licences**	**On-licences**	**Bottle stores**	**Hotels/ taverns/bars**	**Supermarkets/ general stores/dairies**	**Unemployment**	**% 15-24**	**% Māori**	**% Males**	**% Adults**
Licensed Premises	0.02															
Public/Roads	0.64**	-0.12														
Other	0.26*	0.77**	0.09													
Total	0.90**	0.28*	0.80**	0.50**												
All outlets	0-.22	0.32**	-0.20	-0.07	-0.16											
Off-licences	-0.19	0.29*	-0.25*	-0.05	-0.17	0.968**										
On-licences	-0.24*	0.32**	-0.13	-0.08	-0.14	0.967**	0.871**									
Hotels/ taverns/ bars	-0.25*	0.33**	-0.20	-0.07	-0.17	0.263*	0.321**	0.186								
Bottle stores	0.16	0.05	0.14	0.01	0.16	0.986**	0.929**	0.978**	0.136							
Supermarkets/ general stores/dairies	-0.19	0.22	-0.28*	-0.06	-0.19	0.831**	0.881**	0.725**	0.256*	0.755**						
Unemployment	0.32**	-0.09	0.27*	0.25*	0.32**	-0.50**	-0.47**	-0.50**	-0.06	-0.51**	-0.39**					
Percentage 15-24	-0.01	-0.08	0.16	0.15	0.07	-0.44**	-0.48**	-0.37**	-0.09	-0.42**	-0.40**	0.51**				
Percentage Māori	0.22	0.21	0.06	0.39**	0.26*	-0.15	-0.10	-0.20	0.05	-0.18	-0.09	0.74**	0.14			
Percentage Males	-0.22	0.23*	-0.33**	-0.06	-0.23	0.58**	0.55**	0.58**	-0.10	0.60**	0.53**	-0.40**	-0.27*	-0.03		
Percentage adults	-0.26*	-0.00	0.04	-0.29*	-0.18	0.29*	0.23	0.34**	0.15	0.29*	0.19	-0.61**	-0.16	-0.75**	-0.11	
Area dep quintiles	0.26*	0.01	0.21	0.24*	0.28*	-0.17	-0.13	-0.20	0.04	-0.18	-0.18	0.75**	0.28*	0.74**	-0.19	-0.61**

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Appendix 57: Results for collinearity tests amongst variables with shaded areas showing evidence of collinearity

	Eigen value	Condition index	Constant	Unemployment	% 15-24	% Māori population	% male	% adult	NZ deprivation
Constant	6.531	1.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unemployment	0.347	4.339	0.00	0.00	0.00	0.11	0.00	0.00	0.02
Percentage 15-24	0.064	10.135	0.00	0.04	0.01	0.43	0.00	0.00	0.41
Percentage Māori	0.044	12.244	0.00	0.21	0.08	0.00	0.00	0.00	0.53
Percentage male	0.014	21.527	0.00	0.47	0.89	0.18	0.00	0.00	0.03
Percentage adult	0.001	108.262	0.00	0.06	0.01	0.29	0.26	0.42	0.00
Area Deprivation	8.98	269.651	1.00	0.22	0.01	0.00	0.73	0.58	0.01

Dependent Variable: dwelling crime rate