Sex, drugs, smokes and booze: What's driving teen trends?

Describing and explaining trends in adolescent sexual behaviour, cannabis use, smoking and alcohol use in the early 21st century

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Abstract

Today's adolescents are far less likely to smoke, drink, use drugs or be sexually active than their 1990s counterparts. My doctoral project set out to describe and explain trends in adolescent risk behaviours in the early 21st century, considering not only New Zealand but also other high-income countries that have seen dramatic declines in adolescent risk behaviours over the past 15-20 years. To date, this megatrend in adolescent behaviour has not been widely recognised within public health, much less explained.

My research questions were:

1. What are the key trends in adolescent sexual behaviour and substance use (tobacco, alcohol, cannabis) in New Zealand, Australia, England and USA, 1990-2017? What do the patterns suggest about the possible drivers of risk behaviour decline?
2. What does analysis of repeat cross-sectional data from New Zealand reveal about the drivers of declining risk behaviour in secondary school students in this country?
3. What are the possible explanations for the international decline in adolescent risk behaviours? How plausible are these explanations, based on existing theory and evidence and the findings of my own empirical analyses?
4. Do the observed declines represent separate trends with separate drivers; a single trend with common underlying driver(s); or knock on effects with declines in one risk behaviour leading to declines in others?

Key trends

I collated data from New Zealand, Australia, England and the USA on trends in smoking, drinking, cannabis use, and sexual behaviour among adolescents aged less than 16. I found strong declines in all of these behaviours over the past 15 to 20 years. However, there were no corresponding improvements in adolescent fruit and vegetable intake, physical activity, condom use or mental health. In fact, there were significant declines in many of these indicators. These trends were common to most (but not all) high income countries, and were distinct from adult trends.

The patterns observed provide clues as to possible drivers. For example they suggest adolescents are not becoming healthier or more health-conscious in general. Countries with very different regulatory environments have similar trends, suggesting that public health interventions are probably not the primary driver. Similarities across countries and behaviours are suggestive of broad socio-cultural

changes impacting on many behaviours simultaneously. However, other clues (e.g. a lag of several years between smoking decline and declines in alcohol indicators in many countries) point to the importance of behaviour-specific factors.

Changing social context

I investigated the changing social context, identifying some of the broad social changes that have influenced the experience of adolescence over the past 30 years. These include:

- greater social concern about health and safety
- greater awareness of the harms of substance use
- more involved and protective parenting
- increasing pressure on adolescents to prepare for a competitive job market
- increasing exclusion of young people from public space
- increasing time spent engaged in digital media use
- declining exposure to pro-smoking influences.

My literature review revealed that many hypotheses for declines in adolescent risk behaviours had been discussed in the literature but few had been empirically tested using rigorous methods.

Drivers of risk behaviour decline in New Zealand

Having identified potential contributory factors, I tested those for which repeat cross-sectional data was available in nationally representative New Zealand surveys: the annual ASH Year 10 Snapshot (2003-2015) and the Youth 2000 series (2001, 2007, 2012). Using regression analyses, I investigated the extent to which each hypothesised contributor accounted for trends in adolescent smoking, cannabis use, binge drinking and sexual activity in New Zealand secondary students aged less than 16 years.

My findings provide evidence *against* several hypotheses. Factors that *did not* make a statistically significant contribution to adolescent trends in New Zealand included:

- parental smoking, drinking and cannabis use in the home
- sibling smoking
- exposure to others' smoking in the home
- parental monitoring
- family connectedness

- school connectedness
- time hanging out with peers
- engagement in paid work.

The main factors that influenced trends were i) large declines in the proportion of adolescents who thought smoking and drinking were acceptable in people their own age, and ii) impacts of risk behaviour trends on one another. Trends in adolescent smoking and binge drinking appear to be primarily driven by tobacco-specific and alcohol-specific factors respectively, in particular attitude changes. In contrast, declines in cannabis use and sexual activity were largely explained by declines in smoking and binge drinking. Common underlying drivers in home, school, and leisure contexts only made a very minor contribution in combination. However, the pattern of findings in the latter half of the study period (2007-2012) is consistent with a decline in going out at night with friends leading to fewer opportunities for all four risk behaviours.

I used survival analysis to investigate whether age of initiation (i.e. the age that young people try smoking, drinking, using cannabis and having sexual intercourse for the first time) changed over the study period among secondary school students. I found that, consistent with US and Australian studies, age of initiation for all four outcomes increased between 2007 and 2012 in New Zealand. These findings indicate that increasing age of initiation (though not a causal explanation) helps to explain the observed risk behaviour trends in secondary students.

Explanations for the international decline in risk behaviour

While a full explanation for international risk behaviour trends remains elusive, some key drivers are beginning to emerge from the international evidence and my own findings. The empirically-established contributors identified thus far are mainly tobacco-specific and alcohol-specific factors such as parental rules and expectations, decreasing ease of access, and decreasing adolescent approval of smoking and drinking. Knock on effects from one risk behaviour to another also appear to be important, with evidence both from my own research and international studies indicating that declining smoking and drinking significantly explain declining cannabis use in this age group. A common driver underlying declines in many risk behaviours is a decline in unsupervised time and space. In particular, adolescents are going out with their friends in the evenings less frequently, thereby reducing opportunities for risk behaviours. It seems likely that broad social changes have created a milieu in which these more proximal factors have emerged.

International evidence does not support the hypothesis that digital media use has displaced risk behaviour in terms of time use. However, the possibility that the digital revolution has contributed to a shift in the social meaning and function of substance use and sex (e.g. as rites of passage) cannot be excluded.

Separate trends, single trend, or knock on effects?

Behaviour-specific factors, common drivers, and knock on effects all appear to have played a role in the decline of adolescent risk behaviours. It is likely that broad cross-national influences (e.g. the digital revolution, labour market changes) are *interacting* with behaviour-specific factors (e.g. less permissive parental attitudes to youth alcohol use) and the existing culture in each country to produce the pattern of trends that has been observed.

Conclusion

The findings suggest that the picture is complex, with multiple drivers and bi-directional relationships operating in a dynamic system. The finding that risk behaviour trends impact strongly on one another underlines the importance of investigating more than one risk behaviour at a time, and exploring the relationships between them. My thesis highlights both the importance for public health of tackling complex questions about how and why behaviour changes at the population level, and also the limitations of our current tools for dealing with complexity. Overcoming these limitations may require new interdisciplinary collaborations, new methods, and new ways of thinking, but the rewards are potentially transformational.

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The generosity and support of many people have contributed to this thesis, and made my doctoral journey a rewarding one. I'm grateful to be surrounded by supportive friends, family, and colleagues, and there are several people and organisations I want to thank specifically.

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I would like to acknowledge the data-owners, ASH New Zealand and the Adolescent Health Research Group, who provided me with access to the ASH Year 10 Snapshot Survey data and the Youth 2000 Survey data respectively. In particular, my thanks go to Associate Professor Terryann Clark, Principal Investigator of the Youth 2012 survey, for her enthusiasm and support, and to Associate Professor Simon Denny who dealt so patiently with my numerous technical questions and data requests.

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And finally thanks to my daughter, Rita, whose enthusiasm for life gives me great pleasure and a daily reminder about what really matters. You can have your mum back now.

Statement of participation

I conducted one component of my thesis as part of a research team comprising Richard Edwards (Principal Investigator), Dalice Sim (Statistician) and myself. This was an analysis of the ASH Year 10 data set and is presented in Chapter 5. We secured a University of Otago Research Grant (UORG) which partially funded this work. I was lead author of the UORG funding application, analysis plan and resulting publications, and had substantial input into the study design and modelling approach. I also completed the descriptive analysis. Richard Edwards provided direction and oversight and Dalice Sim was the consultant statistician on the project and completed the data cleaning/assembly, multivariable analysis and ecological analysis. To date, this work has resulted in several conference contributions and two publications, detailed overleaf.

Another multi-authored paper, based on analysis of the Youth 2000 data set, has also been published (details overleaf). It is a descriptive paper on the decline in adolescent cannabis use in New Zealand. I took the lead on analysis planning, data manipulation, statistical analysis and manuscript preparation. My supervisors, Richard Edwards, Dalice Sim and Hera Cook contributed at the concept stage, as did Terry Fleming, Terryann Clark and Simon Denny of the Adolescent Health Research Group (the data owners). Dalice Sim and Simon Denny provided statistical advice and support, with James Stanley also contributing advice on managing missing data and designing sensitivity analyses. All of the authors provided input on early drafts of the manuscript, and on revisions following peer review.

Dissemination of findings from this thesis

Peer reviewed journal articles

Ball J, Sim D, Edwards R, Fleming T, Denny S, Cook H, Clark T (2019) Declining adolescent cannabis use occurred across all demographic groups and was accompanied by declining use of other psychoactive drugs, New Zealand, 2001-2012. New Zealand Medical Journal **132**(1500):12-24.

Ball J, Sim D, Edwards R (2018) Why has adolescent smoking declined dramatically? An investigation of changing exposure to risk factors using analysis of repeat cross-sectional data from New Zealand, 2002 – 2015. BMJ Open **8**(10): e020320.

Ball J, Sim D, Edwards R. (2018) Addressing ethnic disparities in adolescent smoking: Is reducing exposure to smoking in the home a key? Nicotine and Tobacco Research **21**(4): 430-438.

Conference contributions

Ball J, Edwards R, Cook H, Sim D (2019) Trends in smoking, drinking, cannabis use and sexual behavior in Australia, England, New Zealand and the USA 1990-2017: What are the patterns, and what do they suggest about the causes of declining adolescent risk behaviour? Kettil Bruun Society Thematic Meeting: Youth Drinking in Decline, 10-12 April, Krakow, Poland.

Ball J, Edwards R, Sim D, Cook H (2019) What's driving the decline in adolescent binge drinking in New Zealand? Kettil Bruun Society Thematic Meeting: Youth Drinking in Decline, 10-12 April, Krakow, Poland.

Ball J, Sim D, Edwards R, Cook H (2018) Have changes in parenting, in particular parental monitoring and parental warmth, contributed to sharply declining adolescent substance use since 2001? European Association of Research on Adolescence Conference (EARA), Sept 12-15, Ghent, Belgium.

Sim D, Ball J, Edwards R (2018) Examining the association between increasing tobacco prices and adolescent smoking. Proceedings of the Society for Nicotine and Tobacco Research (SRNT), Feb 21-24, Baltimore, USA.

Ball J, Edwards R, Cook H (2017) Why are New Zealand's rates of teen smoking, drinking, drug use and pregnancy much lower now than in the 1990s? PHANZ Conference, October 2017, Christchurch, New Zealand

Ball J, Edwards R, Cook H (2017) Why are the adolescents of today in many high income countries less likely to smoke, drink, take drugs or have sexual intercourse than those in the 1990s? Proceedings of the 15th World Congress on Public Health, 3-7 April 2017, Melbourne Australia.

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Glossary of abbreviations

ASH	Action on Smoking and Health
ASSAD	Australian Secondary Students Alcohol and Drug Survey
CI	Confidence interval
dL	decilitre
ESPAD	European School Survey Project on Alcohol and Other Drugs
GCSE	General Certificate of Secondary Education
HBSC	Health Behaviour in School-aged Children survey
ID	Identification number
IUD	Intra-uterine device
M-CASI	Multimedia computer-assisted self-administration interview
MTF	Monitoring the Future survey
NCEA	National Certificates of Educational Achievement
NEET	Not in employment, education, or training
NSASSSH	National Survey of Australian Secondary Students and Sexual Health
NSDUH	National Survey on Drug Use and Health
NZEO	New Zealand European and Other
NZHS	New Zealand Health Survey
OECD	Organisation for Economic Cooperation and Development
OR	Odds ratio
PoS	Point of sale
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
SDD	Smoking, Drinking and Drug use among Young People in England survey
SES	Socio-economic status
STI	Sexually transmitted infection
UORG	University of Otago Research Grant
WHO	World Health Organization
YRBS	Youth Risk Behavior Survey

CHAPTER 1: INTRODUCTION

Sex and drugs and rock and roll

Is all my brain and body need

(Song lyrics, Ian Dury, 1977)

Project aim

Being an adolescent in today's world is a very different experience from being an adolescent in the late 20th century. One aspect is that today's adolescents are far less likely to smoke, drink, take drugs or be sexually active than their 1990s counterparts. Although this seismic shift in adolescent behaviour has been highlighted in the media, with accompanying speculation about possible explanations (Cowley & Wigmore 2016, Richtel 2017), it has received little research attention, and the drivers of the observed trends in adolescent risk behaviours are not well understood. The current project aims to fill a significant gap in the literature by describing recent trends in key adolescent risk behaviours in selected high-income countries, and exploring possible explanations for the observed trends.

Public health importance

Adolescence is a time of transition, development and change that is both important in itself and sets the foundation for adult health (Sawyer et al. 2012). As such, it is a time of great opportunity but also vulnerability. Many lifelong health behaviours become habitual during adolescence – for good or ill – and consequently successful health promotion in the adolescent years is central to health improvement in the population as a whole. In populations with a youthful age structure (e.g. New Zealand's Māori and Pacific populations) preventative approaches in adolescence provide major opportunities for improving the health of these populations.

From an epidemiological perspective there is little or no health benefit to counterbalance the potential harms of substance use (including tobacco, alcohol and illicit drug use) or precocious or unprotected sex. Therefore, within public health, such adolescent risk behaviours tend to be uncritically viewed as unwanted or negative behaviours that should be minimised or eliminated for the betterment of population health. However, from a developmental point of view, some degree of participation in risk behaviours can be seen as normal and functional, as young people gain independence and experiment with 'adult' behaviour and roles (Bonino et

al. 2005, Moffitt 2006). Developmentally, risk behaviours have benefits as well as risks. For example, they may help young people gain peer esteem and establish autonomy from parents. Such goals 'are characteristic of ordinary psychosocial development, and their centrality helps to explain why risk behaviours that serve such functions are so intractable to change' (Jessor 1991 p 598).

Notwithstanding the developmental function of risk behaviours in adolescence, substance use and unprotected sex can undeniably have negative or even catastrophic consequences. Alcohol consumption is strongly associated with the three main causes of death and injury among Western youth; namely suicide, motor vehicle crashes and violence (Cohen & Potter 1999, Khan et al. 2018). Furthermore the leading preventable cause of death across the life course – smoking – is generally initiated in adolescence (Centers for Disease Control 2012). Youthful 'experimentation' with substance use, sex, and other risk behaviours can also lead to addiction, a criminal record, unintended pregnancy, infertility or debilitating injury, sometimes with lifelong or even intergenerational effects. Therefore, understanding and, as appropriate, reducing or preventing potentially harmful adolescent risk behaviour is of great public health importance. As such, concurrent declines in multiple adolescent risk behaviours are good news for public health, yet, to date, efforts to understand the reasons for these declines have been minimal.

Public health research priorities tend to be *problem* focused, perhaps leading to a tendency to 'leave well alone' when indicators are trending in the 'right' direction. But understanding why adolescent risk behaviour has *declined* in recent years is important. How can we learn from and build on positive trends if we do not know what is behind them? Greater understanding of the forces that influence population level trends is needed to inform action to ensure healthy trends are maintained. Such understanding may also suggest strategies for creating behaviour change in geographical areas or demographic subgroups in which risk behaviours remain prevalent.

Current knowledge and evidence gaps

Risk and protective factors for specific adolescent risk behaviours are well established, having been extensively researched for many decades via cross-sectional, longitudinal and cohort studies. Aetiological studies have mostly focused on exploring the influence of individual factors (e.g. sex, ethnicity, genetic factors, personality traits, knowledge, attitudes, and behaviours) and family factors (e.g. socio-economic status, family structure, parental

education, and parenting factors) on the propensity of individual adolescents to engage in risk behaviours. The body of research exploring broader contextual and ecological factors (e.g. neighbourhood factors, school climate, economic factors, and the impact of policies) and their relationship with adolescent risk behaviours at the individual level is smaller, but still extensive. Recent advances in neuroscience, epigenetics and behavioural economics have also contributed to our understanding of the aetiology of adolescent risk behaviour.

Most developed countries undertake surveillance of trends in adolescent substance use and outcomes such as teen pregnancy and road deaths. Overall, trends in many adolescent risk behaviours appear to be following a similar pattern in many high-income Western countries, with rises in the 1990s followed by sharp falls from the late 1990s or early 2000s continuing to the present. However, this international megatrend (i.e. a widespread and sustained shift in behaviour that is large in scale, magnitude and impact) has not been widely recognised in the academic literature. Reports on risk behaviour trends tend to focus on a single country and/or a single behaviour (or set of behaviours), and, to my knowledge, trend data has not previously been collated to bring the 'big picture' into view.

In spite of the public health importance of adolescent risk behaviour, and speculation about the possible causes of recent declines, little research has investigated possible drivers of trends at the population level, or tested hypotheses empirically. What little research has been undertaken has generally focused on a single risk behaviour (e.g. alcohol use) in a single country. Empirical research aimed at understanding the causes of the contemporaneous declines in multiple adolescent risk behaviours is extremely limited. Importantly, we know little about the extent to which declines in risk behaviours, internationally, are the result of deliberate prevention efforts, or whether they stem from broader environmental, social or cultural changes.

Research questions

The current project aims to fill a significant gap in the literature by describing recent trends in adolescent risk behaviours (in particular, smoking, alcohol and cannabis use, and sexual behaviour) in selected countries and exploring possible explanations for the observed trends. A range of hypotheses will be identified and tested, either empirically using New Zealand data, or with reference to existing evidence.

My overarching research questions are:

1. What are the key trends in adolescent sexual behaviour and substance use (tobacco, alcohol, cannabis) in New Zealand, Australia, England and USA, 1990-2017? What do the patterns suggest about the possible drivers of risk behaviour decline?
2. What does analysis of repeat cross-sectional data from New Zealand reveal about the drivers of declining risk behaviour in secondary school students in this country?
3. What are the possible explanations for the international decline in adolescent risk behaviours? How plausible are these explanations, based on existing theory and evidence and the findings of my own empirical analyses?
4. Do the observed declines represent separate trends with separate drivers; a single trend with common underlying driver(s); or knock on effects with declines in one risk behaviour leading to declines in others?

My approach to addressing these questions is outlined below.

Project scope

Countries

Recent declines in adolescent risk behaviours have been observed in many countries, for example many Anglophone, Western European and Northern European countries and other high-income countries such as Japan. My focus in this project is particularly on trends in New Zealand, Australia, England and the USA, since these countries are culturally similar and have available data. Chapter 3 explores trends in risk behaviours in these four countries, and the extent to which trends in these countries are typical of other high-income nations. The other empirical components of my thesis (Chapters 5-8) are based on New Zealand data, which – given New Zealand's similarity with the other countries of interest in terms of trends and risk factors – may help to inform understanding of international trends.

Age-group

For the purposes of this project I will focus on secondary school students, particularly those in early- to mid-adolescence (approximately 12-15 years of age). The reasons for focusing on younger adolescents are two-fold. First, the immediate and long term risks of smoking, drinking, drug use and sexual intercourse are greater when they are initiated at an early age (DuRant et al. 1999, Finer & Philbin 2013, Moss et al. 2014, Heywood et al. 2015). The evidence for this assertion is discussed in detail in the following chapter.

The second reason is a pragmatic one: the majority of adolescent research is conducted via school-based surveys, which are broadly representative of the adolescent population for those under the school leaving age. Beyond the school leaving age, however, school-based surveys are not representative, since those who remain at school tend to be more academically-inclined, and those who leave school early are more likely to be heavily engaged in risk behaviours (Suh & Suh 2007, De Witte et al. 2013). Furthermore, the proportion of students who continue secondary school beyond the school leaving age has increased over recent decades in New Zealand and the other countries of interest, thus adding an element of methodological complication to analysis of long term trends in older adolescents. New Zealand's school leaving age is 16 years, which is similar to or lower than that in other high-income countries, hence my focus on adolescents less than 16 years of age.

Risk behaviours

As previously noted, the risk behaviours I have chosen to focus on are substance use (tobacco, alcohol and cannabis use in particular) and sexual behaviour (underage and unprotected sex). In my empirical analysis of New Zealand data (Chapters 5-8) the specific outcome indicators used are:

- past month tobacco smoking
- past month binge drinking
- past month cannabis use
- sexually active (i.e. had sexual intercourse within the past three months).

Although these behaviours differ in important ways, including the extent to which they become more acceptable with increasing age, they have often been grouped in the literature. They are grouped because they share commonalities and tend to cluster: they all typically take place in contexts of unsupervised leisure time with peers, often at night, and their (perceived) adult-like status is thought to give them a similar symbolic function for adolescents (Moffitt 2006, de Looze 2013, de Looze et al. 2015c). A further characterising feature of sex and substance use is that, although they may be risky in health terms and socially proscribed for younger adolescents, they are also (often) pleasurable and sociable activities. Perhaps because of this association with pleasure – and because restraint from 'pleasures of the flesh' is regarded a moral virtue within Christianity and other religions – another commonality is that substance use and sex have been objects of recurring moral panics about youth behaviour, and held up as symbols of moral decay (McRobbie & Thornton 1995).

There are other risk behaviours and health behaviours of public health importance that I have chosen not to focus on. For example, risky driving is also a major public health concern, with road deaths a leading cause of mortality in adolescents, but it is of limited relevance for the age group below the legal driving age which is the focus of my research. Other behaviours such as physical fighting and petty crime tend to be framed as social problems rather than health issues and are qualitatively different from substance use and sex in that they are not typically seen as pleasurable activities. Health behaviours such as eating and sleeping habits and physical activity have major implications for health, but have not been the subject of longstanding and adolescent-specific public concern. These wider risk behaviours and health behaviours are touched upon in Chapter 3, but they are not the main focus of my project.

Methodological orientation

Lack of empirical research into the determinants of declining risk behaviour at the population level is at least partly due to the methodological challenges of undertaking such research. As Rose argues in his seminal paper *Sick individuals and sick populations* most epidemiological research designs depend on the presence of individual variation in exposure to determinants in order to identify associations between exposures and outcomes at the individual level (Rose 2001). Exposures that affect a whole population (e.g. changes in economic climate, national policy changes, or the digital revolution) are rendered invisible by such techniques, since there is no way to compare the outcome of interest between 'exposed' and 'non-exposed' groups.

One way of overcoming this problem would be to use nations or states as the unit of comparison, for example comparing countries in which adolescent risk behaviour is declining with 'outlier' countries that defy the general trend. This was an approach that I considered but rejected for pragmatic reasons, since availability of and access to the necessary data was likely to be problematic, and a deep understanding of the culture and context of each country would be needed to conduct such research robustly. Such research would best be conducted in collaboration with in-country researchers from each jurisdiction, an approach which was not feasible for this doctoral project.

The most common approach taken to date in both the media and the academic literature is to identify other trends concurrent with declines in risk behaviour (e.g. the rise in digital media, increasingly involved/protective parenting, more leisure options, or falling real wages for young people) and then speculate that these may be causal factors. However, correlation is not causation. It is notoriously difficult to control for potential confounders in ecological

studies and therefore the temporal correspondence of population trends is a relatively weak form of evidence.

Analysis of nationally representative repeat cross-sectional survey data provides a method to overcome (at least to some extent) the problems of ubiquitous exposures and confounding. Rather than comparing 'exposed' and 'non-exposed' groups, we can compare 'time A' with 'time B', thus picking up changes in exposures and outcomes *over time* rather than *between individuals*. Using aggregated individual-level data enables us to isolate the effects of variables of interest, while controlling for other variables.

However, a further methodological challenge is the complexity of the systems in which adolescent risk behaviours are embedded. Real world behaviour-environment systems are not characterised by simple linear cause and effect relationships, but by a 'web of causation' (Jessor 1991) where causality between elements is often bi-directional, feedback loops are common, and influences on behaviour are multiple and diffuse (Byrne 2013). Hence, complex questions about why adolescent behaviour is changing cannot be solved through data analysis alone.

Establishing causation relies on reasoned judgement based on accumulated evidence: there is no study design that can 'prove' causality definitively. And although there are widely applied criteria for causality e.g. association, time order, direction (Susser 1991), in the complex world of multi-causality and bi-directional causation, even these criteria are not absolute (Phillips & Goodman 2004, Rothman & Greenland 2005). For example, an important determinant may not necessarily co-vary with the outcome of interest over time at the population level, as its effects may be over-ridden by other factors. For instance, an improvement in parenting in the UK in the 1990s coincided with rising problem behaviour in adolescents (Collishaw et al. 2012). This lack of association at the population level does not 'disprove' the causal role of good parenting in preventing problem behaviour in adolescents. Rather it suggests that other factors (e.g. perhaps the introduction of alcopops, or poor job prospects for young people) may have overridden the positive effects of improved parenting.

In short, my project cannot definitively prove or disprove any hypothesis for adolescent risk behaviour decline, but it can contribute empirical evidence for or against hypothesised causes and contribute to the development of explanatory theory. Furthermore, I can make reasoned and theoretically-informed judgements about the most plausible explanations based on the accumulated evidence to date.

My project as a whole takes an interdisciplinary approach, drawing particularly on epidemiology, sociology and developmental psychology. This interdisciplinary approach enables exploration of the trends in adolescent risk behaviour and how these are patterned, and also how changes in the wider social context may be influencing adolescent behaviour. My empirical work uses epidemiological methods, however the design and interpretation of findings is informed by theory and evidence from other disciplines.

Outline of thesis

Chapter 2 describes the theoretical framework for the project, defines key terms and outlines important background information about adolescent risk behaviour, including known risk and protective factors. It also provides an overview of some of the broad social changes that have profoundly influenced the experience of adolescence over the past 30 years.

Chapter 3 presents a comprehensive description of trends in adolescent risk behaviours since 1990. I have collated nationally representative data on trends in adolescent alcohol, tobacco and illicit drug use (in particular, cannabis), and trends in sexual behaviour and teen pregnancy in New Zealand, Australia, England and the USA. Correspondence with adult trends over the same period, and, where possible, distribution of changes over time by gender, ethnicity and socio-economic position are also presented. The extent to which the patterns observed are typical of other high-income countries, and other health and behaviours is also examined. The purpose is to describe in detail the phenomenon that is the focus of my project: that is, the decline in many risk behaviours across many Western countries over the past 15-20 years. Detailed observation provides clues as to the possible drivers of population level change, and these are discussed at the conclusion of Chapter 3.

Chapter 4 provides a critical review (informed by systematic review methodology) of research aimed at explaining population-level changes in adolescent risk behaviour, with a focus on tobacco smoking, alcohol use, cannabis use and sexual behaviour. It draws on academic literature from a number of disciplines, and includes relevant reports from government agencies and non-government think tanks and research bodies. The quality of the evidence is discussed and the gaps in the literature are highlighted. This discussion anticipates the following four chapters, which present the empirical components of my project, and test specific hypotheses.

Chapter 5 is the first of four chapters presenting my empirical research based on analysis of repeat cross-sectional data from New Zealand. It explores the question of whether the dramatic fall in smoking in Year 10 students (aged 14-15) between 2002 and 2015 can be explained by changes in important tobacco-specific risk factors – parental, sibling and peer smoking, and exposure to others' smoking in the home. This trend analysis is based on data from the annual Action on Smoking and Health (ASH) Snapshot Survey, a large nationally representative survey on adolescent smoking.

Chapter 6 provides further descriptive detail on the concurrent declines in smoking, binge drinking, cannabis use, and sexual activity in 13-15 year olds in New Zealand over the 2001-2012 period. It tests the hypothesis that changes in 'common determinants' (i.e. those that are associated with risk behaviours generally rather than one specific risk behaviour) have contributed to this phenomenon. The trend analysis includes factors in family, school, and leisure settings (e.g. parental monitoring, family connectedness, school connectedness, and time hanging out with friends). It is based on data from the National Survey of the Health and Wellbeing of New Zealand Secondary School Students (commonly called the Youth 2000 survey series), which was conducted in 2001, 2007 and 2012.

Chapter 7 examines changes over time in age of initiation, adolescent attitudes to substance use and parental modelling, also using Youth 2000 data. Survival analysis is used to test the hypothesis that the typical age young people engage in smoking, drinking, cannabis use and sexual intercourse for the first time has increased in successive cohorts, contributing to observed declines in prevalence of these behaviours in 13-15 year olds. Trend analysis is used to investigate the extent to which changes in adolescent attitudes to substance use and parental substance use account for declines in smoking, binge drinking, cannabis use and sexual activity in this age group.

Chapter 8 explores the influence of risk behaviour trends on one another, and tests the hypothesis that declines in cannabis use and sexual activity are largely knock on effects resulting from declines in the other risk behaviours examined. Then, all of the potential contributing factors explored in the previous two chapters are included in fully adjusted models to determine the extent to which, collectively, they account for smoking, binge drinking, cannabis and sexual activity trends. The fully adjusted models also show the independent contribution and relative importance of each factor, after adjusting for all the other factors.

Chapter 9 is a discussion chapter which draws together the findings of the thesis as a whole, and addresses the research questions posed in Chapter 1. The strengths and limitations of my doctoral project are discussed, along with remaining questions for further research, and implications for theory and practice.

CHAPTER 2: ADOLESCENT RISK BEHAVIOUR IN A CHANGING WORLD

Tā te tamariki tāna mahi wāwāhi tahā

It is the job of the children to smash the calabash

(Māori proverb)

This chapter introduces the key concepts, theories, and background information that underpin my approach to this project.

What is adolescence?

The concept of adolescence as a distinct developmental stage between childhood and adulthood, characterised by particular behavioural, emotional and cognitive features, was developed in the late 19th and early 20th centuries. Psychologist G Stanley Hall's *Adolescence,* published in 1907, was a landmark text that popularised the idea of adolescence as a time of 'storm and stress' marked by conflict with parents, mood disruptions and risky behaviour (Hall 1907). This somewhat negative conceptualisation of adolescence has tended to dominate media and academic discourse to the current day, with teenagers often positioned 'both as dangerous and as in danger' (Moran-Ellis 2010, p189).

It is widely agreed that adolescence begins at puberty and ends when adult roles (or the age of legal adulthood) are achieved. Although there is no universally agreed age range for adolescence, the secondary school years (age 12-18) have generally been seen as the core adolescent years. The transition from childhood to adulthood is both a biological and a social process. The social aspect involves preparation for and induction into adult roles, with the nature of those roles and the timing of the transition determined by the culture and historical period in which they occur. A very brief adolescence, marked by rapid entry into work, parenthood and other adult roles at or shortly after puberty, is typical of agrarian societies, which still dominate the world's population (Bonino et al. 2005). For example, in pre-European Māori culture 'all iwi members worked and children were considered adults when they reached puberty' (Te Ara Encylopedia of New Zealand 2016). This contrasts sharply with the lengthy adolescence of post-industrial nations, where young people typically spend 13-16 years in the education system (often necessitating extended economic dependence) and the

transition to work, marriage and parenthood generally occurs more than a decade after the onset of puberty (Settersten & Ray 2010 , Sawyer et al. 2018).

Thus the social aspect of adolescence is heavily context-dependent, and even the biological process of sexual maturation is influenced by context. For example, the average age of menarche decreased by about three months per decade during the twentieth century in high-income Western countries, which has been attributed primarily to improved nutrition (Brooks-Gunn & Petersen 1984).

The mid-20th century saw the rise of developmental stage theories, such as Erikson's psychosocial stages of development (Erikson 1993), which, in contrast to previous thinking, emphasised the life-long nature of human development, and the fundamental role of early childhood, social interaction, and the wider socio-cultural context in individual development. Erikson, a developmental psychologist, conceived of eight developmental stages, five of them up to age 18 and three in adulthood, each framed as a psychosocial crisis to be resolved. He put great emphasis on the adolescent period (age 12-18) since successful resolution of the 'identity versus role confusion' crisis was seen as critical to successful transition to adult roles (Erikson 1980).

Another theorist of the time, working in the field of education, was Robert Havighurst who (with others) developed and popularised the concept of 'developmental tasks'. He defined a developmental task as 'a task which arises at or about a certain period in the life of the individual, successful achievement of which leads to his happiness and to success with later tasks, while failure leads to unhappiness in the individual, disapproval by society, and difficulty with later tasks' (Havighurst 1956). While Erikson saw the fundamental task of adolescence as the achievement of identity, Havighurst and colleagues proposed a range of tasks including: learning an appropriate sex role; achieving emotional independence from parents; developing conscience, morality and a set of values; getting along with peers; and developing intellectual skills (Schoeppe et al. 1953). Within this framework, exploring and experimenting with adult roles and behaviours (e.g. sex and use of alcohol) can be seen as a normal and expected aspect of growing up. The concept of developmental tasks remains current today, and is relevant to the theorisation of adolescent risk behaviour (Bonino et al. 2005).

Developmental stage theories also imply that the aetiology of adolescent behavioural problems may lie in earlier stages of childhood, not necessarily in the immediate environment. Recent developments in neuroscience, nutrition and developmental psychology have

underscored the importance of the early years for healthy development, in particular the period from conception to two years of age (Wachs et al. 2014). Research suggests that maltreatment, malnutrition or other adverse experiences in this critical period can 'leave a lasting signature on the genetic predispositions that affect emerging brain architecture and long-term health' (Shonkoff et al. 2012). For example, adverse childhood experiences have been shown to affect the development of executive functions such as impulse control, decision making and behavioural self-regulation, which may help to explain the well-documented association between early life adversity and risk behaviour in adolescence (Shonkoff et al. 2012). These new findings align with attachment theory, developed in the mid-20th century, which proposes that the quality of the attachment between an infant and primary caregiver has a profound effect on the infant's developmental trajectory (Center on the Developing Child 2010, Zeanah et al. 2011).

In summary, adolescence is the developmental stage between childhood and adulthood, involving sexual and psycho-social maturation. Adolescent wellbeing is important in itself; it is significantly determined by earlier developmental stages, and forms the foundation of adult health and therefore should be viewed within a life course perspective (Ben-Shlomo et al. 2014). The length and nature of the adolescent period is socially determined, and therefore adolescence must be studied within its social context:

> *The integral connection between adolescence and the societal context means that, despite universals such as puberty and cognitive development, adolescents' experiences will vary across cultures and over history. The settings in which young people develop, the skills they are expected to acquire, and the ways in which their progress toward adulthood is marked and celebrated depend on the cultural and historical contexts (Crockett 1997, p23).*

The changing social context

The period from the Second World War to the present has been a time of rapid economic, cultural and technological change (Pavis et al. 1998), and the pace of change has increased over the past 30 years with the rise of free market economics and information technology (Rosa 2013). These changes have had a material impact on young people's transition to adulthood, and have changed the social roles and lived experience of adolescents (Furlong & Cartmel 2007). The impact of this changing social context on adolescents can be understood or explored in a sociological way: by examining major social and historical changes and their

likely impacts on the experience of adolescence. It can also be understood and explored epidemiologically: by looking at changing exposure to known risk and protective factors within the social environment (i.e. factors that are known to increase or decrease the probability of an adolescent engaging in risk behaviours) and how these have contributed to changes in adolescent behaviour. My empirical research takes the latter approach, but it is informed by sociological understandings of the changing social context, summarised briefly below.

Figure 1: Intersecting domains of social change

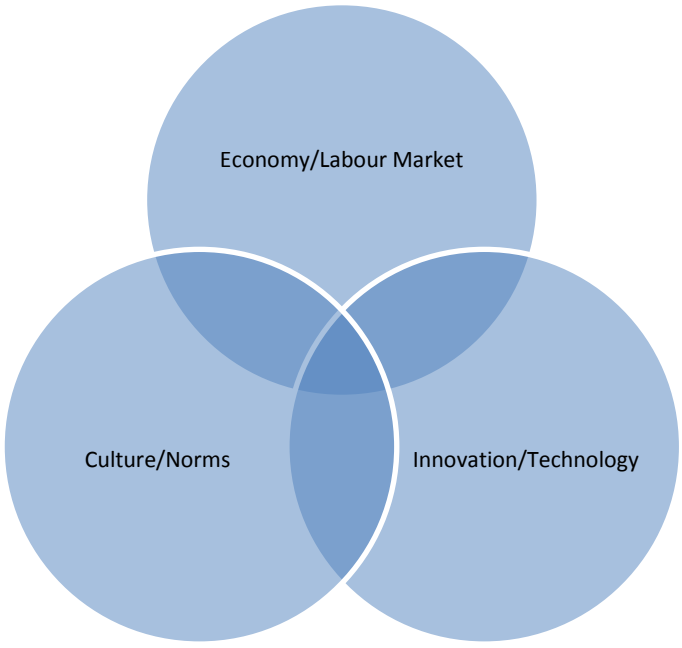


Figure 1 describes three broad and intersecting domains of social change that have modified the context and lived experience of adolescence over the past 30 years. Some of the changes described below are a continuation of changes that began decades earlier (e.g. secularisation, globalisation, consumerism, individualism, changing gender roles), whereas others are specific to the late 20th century and/or early 21st century (e.g. the collapse of the youth labour market, the digital revolution).

From industrial society to risk society

According to sociologists such as Beck (1992) and Giddens (1999) a profound shift occurred during the latter half of the 20th century in which the shadow side of industrialisation and 'human progress' came into focus: i.e. nuclear accidents, loss of biodiversity, pollution, climate change etc. Whereas for hundreds of years people's anxieties were focused on what nature

could do to us (e.g. infectious disease, bad harvests), at some point 'we stopped worrying so much about what nature could do to us, and we started worrying more about what we have done to nature' (Giddens 1999, p 3). Thus, according to these theorists, as 'modernisation' comes up against its limits, our relationship with science and technology changes and becomes more ambivalent. Although scientific and technological innovations have alleviated some risks (infectious disease, famine), they have created others, either directly (like those mentioned above) or by revealing risks hitherto unrecognised (e.g. new carcinogens). As a result, negative outcomes can no longer be seen as 'fate,' 'bad luck' or 'acts of God' but are seen to be *within the domain of human control*. This shift is rooted in the innovation/technology sphere, driven by the economic imperatives of industrial society, but with profound cultural consequences. As Giddens points out, 'a risk society is not intrinsically more dangerous or hazardous than pre-existing forms of social order' but rather it is a society increasingly preoccupied with the future, with safety, and with the desire to control and minimise risks. Beck argues that in such a society, commonality of anxiety takes over from commonality of material need as a driving cultural and political force (Beck 1992).

Current public health and health promotion efforts can be seen as part and parcel of the cultural shift towards prevention and risk management, both reflecting and reinforcing an increased emphasis on risk and safety. Although such efforts have a long history (Rosen 2015) the scale and reach of preventive health interventions increased greatly from the 1980s and 1990s. Interventions often used legislation and/or fear-based messaging to encourage behaviour change in relation to road safety, smoking, substance use and unprotected sex for example (Gagnon et al. 2010). Such preventive interventions have undoubtedly saved thousands of lives, but arguably they have also contributed to a climate of anxiety (Guttman & Salmon 2004, Gagnon et al. 2010). A consequence of the shift towards a 'risk society' is that, whereas in previous generations youth were exhorted to refrain from drunkenness, drug use and pre-marital sex on *moral* grounds, such exhortations are now couched in terms of 'risk', backed up with scientific evidence of potential harm.

A further consequence of rising anxiety about children's and adolescents' safety has been increasing restrictions on freedom to play outdoors and move around their neighbourhoods independently (Shaw et al. 2013, Witten et al. 2013, Pacilli et al. 2015, Schoeppe et al. 2016). Furthermore the perceived 'risk' teenagers pose to public order has led to policy and design interventions to exclude young people from public space including streets, parks and shopping centres (Owens 2002, Travlou 2003, Webb et al. 2004, Kelly 2010, McInroy 2010, Pennay &

Room 2012, Little 2015). As a result, the experience of childhood and adolescence for those born from approximately the late 1980s in most high-income countries has been qualitatively different from that of previous generations who experienced much more freedom of movement.

Although religion remains an important institution and cultural force in some high-income countries, notably the USA, secularisation has been a key strand of cultural change in all the countries of interest. The declining cultural importance of religion in high-income countries is a long-term trend, but one that appears to have accelerated from the 1990s (Zuckerman 2014, Woodhead 2016). Following the decline in religious belief (with its promise of eternal life), health has taken on a more central value in modern society. As Beck-Gernshiem explains: 'When faith in a world beyond has been dissolved, health gains in significance and value, it turns into the expectation of earthly salvation' (Beck-Gernsheim 2000) p 124. When coupled with increasing competition and insecurity in the job market and the ideology of personal responsibility, 'health is no longer so much a gift of God but rather the task and duty of the responsible citizen. S/he has to safeguard, control and care for it, or else s/he must accept the consequences' (p124).

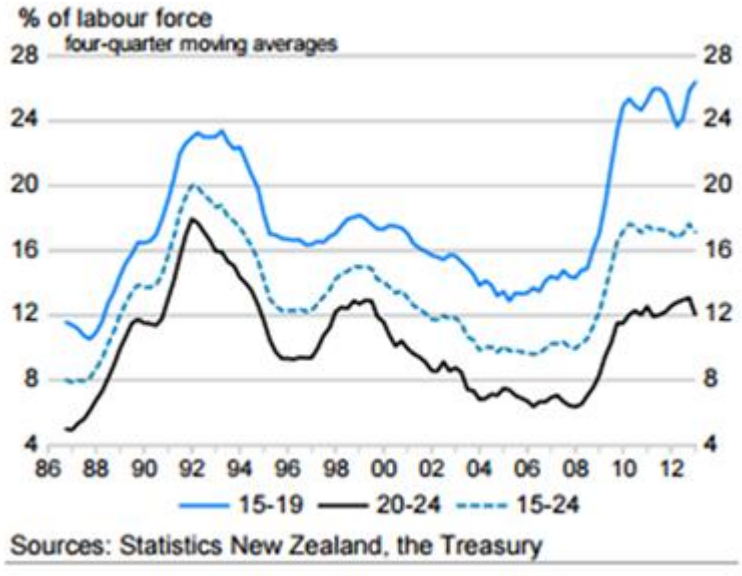
Economic and labour market changes

In the economic arena, globalisation and mechanisation led to the rapid decline of manufacturing and heavy industry in Western nations from the late 1970s, and with it a major loss of jobs traditionally occupied by working class men. The decline in manufacturing jobs in the USA and UK has continued precipitously since the turn of the 20th century (Fort et al. 2018). Technical advances have had a similar impact in sectors dominated by women, for example making secretaries, typists and switchboard operators (once common occupations for young women), virtually obsolete. The resulting structural unemployment, along with deregulation of labour markets and de-unionisation, has served to keep wages low for un-skilled and semi-skilled workers over the past 30 years. 'Low-end' jobs (e.g. cleaning, hospitality, care work), which constitute a high proportion of the jobs created over the past 30 years (France 2016), are not only poorly paid, but have become increasingly insecure and casualised, with workers denied the rights of permanent employees (Standing 2012). As a result, wage growth has slowed and income inequality and insecure employment have increased markedly since the 1980s in almost all OECD countries (Western & Healy 1999, Forster et al. 2011). More recently, precarious employment has spread to white collar jobs (e.g. academia and the creative industries), with the coining of the term 'precariat' to describe

a social class of people (including a high proportion of educated young people) living precariously in insecure casual and contract positions interspersed with periods of unemployment (Standing 2012).

These macro-economic and labour market changes have had a profound effect on young people's transition to work in all OECD countries (Furlong & Cartmel 2007). For example, workforce participation rates (including both fulltime and part time work) of 16-17 year olds in the USA peaked in the late 1970s, and almost halved over the study period from approximately 47% in 1989 to 25% in 2010 (Twenge, 2017, p189). Until the mid-1980s most young New Zealanders left school and entered the workforce aged 15 or 16, but the youth labour market contracted rapidly when neoliberal reforms were introduced from 1984 (Rankin 1993), leading to a spike in youth unemployment. This is illustrated in Figure 2 which shows the proportion of the New Zealand youth labour force (i.e. those seeking work) who were unemployed. Note that unemployment figures do not fully capture the extent of the collapse of the youth labour market, since they do not include young people who remained in school because work was unavailable.

Figure 2: Youth unemployment rate, New Zealand, 1986-2012



Source: (The Treasury 2013)

In New Zealand the school leaving age was raised from 15 to 16 in 1989 in response to the youth unemployment crisis, and, as in Australia and England, school completion rates increased dramatically as the youth labour market contracted in the late 80s and 90s (France

2016).[1] The trend towards young people staying at school longer and a greater proportion leaving school with qualifications has continued during the 2000s. For example, in New Zealand the percentage of school-leavers with a qualification of NCEA Level 2 or above (or equivalent) almost doubled from 40% in 1999 to 78% in 2014.

This trend was partially driven by the global financial crisis of 2007-2008 and the recession that followed it, which led to a futher collapse of the youth labour market in Western economies. This put further pressure on young people to stay in school. Although general employment rates have since recovered, youth employment rates have remained low. In England social concern about NEETs (young people not in employment, education or training) led to a 2015 law change making participation in full time education or training compulsory until 18 years of age. This brought England in line with Germany, Belgium, Portugal, the Netherlands and several other OECD countries that had made education to age 18 compulsory in the years following the global financial crisis. Many states of the USA and Australia have also raised the school leaving age to 17 or 18 in recent years, and although New Zealand has not followed suit with legislation, school completion rates have continued to increase in New Zealand since the global financial crisis. In 2015, 85% of students stayed at school to the age of 17, up from 79% percent in 2009, according to NZ Ministry of Education figures.

In response to the lack of jobs for young people, and the promise of the 'knowledge economy', participation in tertiary education has increased markedly over the study period in almost all OECD countries (OECD 2018c). Whereas a university degree was once the preserve of the academic elite, it is increasingly seen as an entry level qualification for the contemporary job market (France, 2017). While tertiary education became more necessary following the 'structural adjustment' of the 80s and 90s, it also became more expensive in all four countries of interest. Within free market ideology, higher education is seen as a 'private good' (since individuals benefit by way of higher subsequent earnings) and became subject to 'user pays' following the neoliberal turn. In New Zealand the student loans scheme was introduced in 1992, along with hikes in student fees and a tightening of eligibility criteria for student allowances. However, as France (2016) argues, the promise of the knowledge economy has not been fulfilled, since job growth has largely been in low-paid service roles. Growth in highly paid, highly skilled work is yet to materialise.

[1] In the USA secondary school completion rates were already high at about 85% in 1990, and further increased over the study period to 92%. McFarland, J, Stark, P & Cui, J (2016). Trends in high school dropout and completion rates in the United States: 2013. Compendium report. Washington DC, National Center for Education Statistics.

In summary, today's adolescents are spending longer in education than any previous generation, many are gathering considerable debt in the process, and transition to work is typically occurring in the early to mid-20s rather than the mid to late-teens (as was typical in the 1980s). When young people do enter the workforce, their employment is typically insecure and often low paid, further delaying financial independence.

There is evidence that, as well as material impacts, recession and youth unemployment has long-lasting effects on young adults' self-confidence, values, and world-views which do not necessarily change, even when economic circumstances improve (Schoon & Mortimer 2017). Furthermore, there is evidence that increasing uncertainty and precariousness in the job market affects young people well before they begin the transition to working life (Lechner et al. 2016). Concerns about future unemployment are now a key source of future-related stress for adolescents (Lechner et al. 2016, Lessof et al. 2016). A recent study of young people in Germany and Poland found the majority responded proactively to job market uncertainties by re-doubling their efforts to prepare themselves for a competitive job market (e.g. by working hard at school), while a minority responded by disengaging from what were perceived as unattainable goals (Lechner et al. 2016).

Labour-market conditions also appear to have influenced younger adolescents via changes in age-related norms and the extension of 'child' and 'adolescent' categories. Sawyer and colleagues recently argued in *The Lancet* that expanding the definition of adolescence to 10–24 years 'corresponds more closely to adolescent growth and popular understandings of this life phase' (Sawyer et al. 2018). As recently as the 1970s and 80s, 15 and 16 year olds were seen as being on the brink of adult life, with work, marriage and parenthood on the near horizon. But since the 1990s secondary school students have been increasingly positioned as children: cognitively immature, financially dependent, and in need of guidance and protection, with the achievement of adult milestones still far in the distance (Settersten & Ray 2010, Mortimer & Moen 2016). Structural barriers to young people's independence appear to be the key drivers of this discourse. However, the popularisation of the idea (based on neuroscience) that brain maturation continues well into the 20s, and that young people 'may simply be unable to make decisions the same way adults do' also appears to have contributed (Powell 2006).

Changes in parenting and family life

Parenting (and therefore the experience of being parented) has been influenced by all three domains: labour market, culture and innovation. Economic and labour market trends,

combined with changing gender norms, have led to a steady increase in higher education and workforce participation for girls and women since the 1960s. In most OECD countries this trend has continued into the 21st century (OECD 2018b). Consequently, working mothers have become the norm rather than the exception. Greater gender equity and rising educational and career aspirations for women, coupled with innovations in contraceptive technology, have also led to later childbearing, smaller family size, and a changing culture of fatherhood since the 1960s (Morman & Floyd 2002, Ni Bhrolchain & Beaujouan 2012, Bongaarts et al. 2017). These long-term trends have influenced the experience of childhood and adolescence and also the gender roles that adolescents are preparing themselves for in adulthood. But arguably the shift in norms occurred primarily in the late 20th century, with changes since 2000 less marked than in previous decades.

The average age of first parenthood gradually decreased in the decades following World War II, reaching its lowest point in New Zealand in the early 1970s – a pattern common to many Western nations (OECD 2018a). As Cook explains (in relation to UK trends), this was partially due to increasing affluence enabling earlier marriage and household formation (Cook 2004) and may also have been driven by increasing rates of pre-marital sex, particularly following the 'sexual revolution' of the 1960s, leading to unplanned pregnancies. The contraceptive pill was an innovation which had major material and cultural impacts over the next few decades. For example, it contributed to women's liberation and workforce participation, smaller family size, and the liberalisation of attitudes to pre-marital sex. The early 1970s brought both the widespread availability of the pill to unmarried women, and the introduction of the Domestic Purposes Benefit in New Zealand (providing an income for those caring for children without a partner), decoupling sex from pregnancy, and pregnancy from marriage. The early 1970s also marked the beginning of a steep decline in the fertility rates of 15-29 year olds in OECD countries (OECD, 2018), and a rise in the average age at which women had their first child, from early 20s to late 20s (OECD 2018a). Thus, the teens of the 1980s and early 1990s had (on average) younger parents than the cohorts before and after them. And the adolescents of the early 21st century have older and more educated parents than any previous cohort.

Another related demographic change, common to all of the countries of interest, has been increasing diversity in family structure and the living situations of children. In New Zealand the proportion of families with dependent children headed by a sole parent (mostly mothers) increased from 10% in 1975 to a peak of 29% in 2000 (Centre for Social Research and Evaluation 2010), a pattern typical of the other countries of interest. Blended families (i.e.

couples where one or both partners have children from previous unions) have also grown as a proportion of all families. Shared custody of children has become increasingly common and in 2012, 29% of secondary school students in New Zealand reported that they had more than one home (Adolescent Health Research Group 2013). Again, these changes have affected both parenting and the experience of being parented leading up to and during the 1990-2017 study period.

Although data are scarce, there appears to have been a cultural shift in normative parenting style in many high-income countries over recent decades (particularly among fathers) from a more authoritarian and disciplinarian style to a more nurturing, supportive and child-centred style of parenting, characterised by more two-way communication and negotiation (Morman & Floyd 2002). This is evidenced by changing attitudes towards the physical punishment of children, which have shifted dramatically among parents, professionals and lawmakers in recent decades. As recently as the early 1990s, 70% of family physicians in the USA (Durrant 2008) and 87% of New Zealand parents (D'Souza et al. 2016) supported physical punishment in certain circumstances, and only 4 countries had laws prohibiting all corporal punishment of children. By 2000 this number had reached 11, and by 2018, 54 countries had a complete prohibition on corporal punishment of children (Global Initiative to End All Corporal Punishment of Children 2018). Over the past 20 years there has been a growing research and professional consensus that corporal punishment poses a risk to healthy development (Durrant 2008, Durrant & Ensom 2012) and in New Zealand, the proportion of parents condoning physical punishment in certain circumstances had fallen to 40% by 2013 (D'Souza et al. 2016). This represents a more recent shift in parenting norms than the structural and demographic changes discussed above, and therefore the decline in corporal punishment may be particularly pertinent to the decline in adolescent risk behaviours since 2000.

Time use studies and survey data also provide evidence of more involved parenting. Despite the sustained increase in paid work among women since the 1960s, time use studies in many high-income countries show an increase in the time both mothers and fathers invested in their children between the 1960s and 2000 (Gauthier et al. 2004, Sayer et al. 2004). UK surveys of young people in 1986 and 2006 show that parents' expectations and monitoring of their adolescent children increased over this period, along with an increase in quality time spent together (Collishaw et al. 2012). More recently, analysis of ease of communication with mother and father, based on the reports of 11-15 year olds, shows a marked improvement between 2002 and 2010 in most European and North American countries (Brooks et al. 2015).

The digital revolution since the early 1990s, and in particular the rise of the smartphone since approximately 2010, is a technological innovation which has undoubtedly affected parenting. On one hand, digital technology may aid parent-child communication and enhance parents' monitoring and surveillance capabilities, thus mitigating 'traditional' parental concerns about knowing where their adolescent offspring are and what they are doing. On the other hand, new technologies bring new risks, the nature and scale of which are still emerging (Bailin et al. 2014, Marchant et al. 2017). Managing their teens' use of technology and protecting them from perceived risks (e.g. online bullying, sexual exploitation and internet-addiction) is a new parenting challenge and a source of considerable parental anxiety and uncertainty (Potter & Potter 2001, Yardi & Bruckman 2011).

Youth culture

As discussed above, adolescents have been increasingly excluded from public space in recent decades, but since the digital revolution, cyberspace has provided a new space for young people to 'gather' and for youth culture to evolve. The advent of home internet, gaming, social media, and smartphones have led to changes in adolescent social life as young people spend more time communicating electronically and engaging in screen-based entertainment (Iannotti et al. 2009, Lenhart et al. 2015, Antheunis et al. 2016, Twenge 2017).

Arguably, the digital revolution has also diversified the role models available to young people, and the foci of youth culture. While music, fashion and sport remain important, over the past decade an array of young social media stars have emerged as the new celebrities who shape what is 'cool' among their millions of followers (Kay 2017, Stokel-Walker 2018, Wollaston 2019).

Felix Kjellberg (known on You Tube as 'PewDiePie') is one such celebrity. Born in 1989, he dropped out of university in 2011 to play video games full time, uploading videos of himself to You Tube, in which he plays video games with amusing commentary (Parker 2015). While the appeal of 'passive gaming' (i.e. watching someone else play video games) may be hard to fathom for anyone aged over 30, his videos quickly became popular and by mid-2012 he had a million subscribers. In the intervening years his following has grown exponentially and at the time of writing, PewDiePie was the most popular You Tube channel globally with 96 million subscribers (i.e. about 20 times the population of New Zealand). He is a multimillionaire, making money primarily from the advertising on his channel, and, like the celebrities of yesteryear, he is mobbed by fans when he appears in public. *Time* magazine named him one of the world's 100 most influential people in 2016.

The influence and reach of these social media celebrities has given rise to a new marketing tool: the 'influencer' who is paid to endorse products or brands via his or her social media channels (Kay 2017, Mediakix Team 2018). With the rise of online marketing, the lines between paid advertising, celebrity endorsement, and entertainment have become increasingly blurred. This makes regulation of tobacco and alcohol marketing to adolescents difficult in the internet age, with industry quick to exploit new opportunities (Uzunoğlu & Öksüz 2012, Lobstein et al. 2017). Although certain brands (e.g. Coca Cola, Nike, Dr Martens, Marlboro) have long been signifiers of youth identity and sub-cultural affiliation, the internet has created new opportunities for the enmeshment of youth culture and commercial interests e.g. via 'user generated content' (Wasko 2008, Freeman 2012, McCreanor et al. 2013).

The rise of electronic media and 'home-tainment' have been implicated in the sharp decline of the night time economy in England and the USA (White 2016). In the 10 years from 2005 to 2015 the number of British nightclubs almost halved from 3,144 to 1,733 (Stokel-Walker 2016), while the number of pubs fell by 20% between 2000 and 2017 (Statista 2019). Meanwhile in the USA the number of bars fell by 17% in the decade between 2004 and 2014. The causes are likely to be complex, but a change in youth culture – from 'hedonism' to 'homebody' – seems likely to be part of the explanation (Ganesh 2018).

Summary

In total, the economic, cultural and technological changes over the past 30 years have profoundly changed the nature of adolescence, such that it is 'more protracted, more individualized, and less linear than it was in the past' (Jager et al. 2015). Young people have more choice, but, as architects of their own future, they also bear 'crushing responsibility to make the *right* life choices' (Tulloch & Lupton 2003). Both in New Zealand and in other OECD countries rates of school completion have increased markedly (Rea & Callister 2009) and the age at which young people are transitioning to adult roles (driving, full time employment, living independently, parenting) has also increased over the study period. Particularly since 2000, adolescents' leisure time has become increasingly screen-based, as has their social life, and secondary students are less likely to have a part time job. Their parents are (on average) older and better educated than previous generations, and more involved in their teens' lives.

This brief overview of some of the key social changes of the late 20th and early 21st centuries provides important background to the study of why and how adolescent risk behaviours have declined over the past 15-20 years. It provides some understanding of the social context in which the decline in adolescent risk behaviours has occurred; it provides guidance as to the

risk/protective factors in which we might expect to see a change over time; and it enriches understanding of the relationship between the individual and society thereby informing the interpretation of empirical findings.

What is adolescent risk behaviour?

'Risk' in epidemiological terms refers to an increased probability of illness, injury or death, and therefore 'risk behaviour' could be defined as any behaviour (as opposed to environmental factors or biological factors) that increases morbidity or mortality. This is a broad definition which would include poor dietary and sleeping habits, participation in contact sports and adventure sports, and other behaviours statistically associated with illness or injury. In practice, however, the term 'adolescent risk behaviour' is generally applied to behaviours that *both* increase likelihood of morbidity and mortality, *and* are the object of moral disapproval when engaged in by young people, such as smoking, drinking, drug use, fighting, dangerous driving and underage sexual intercourse.

The term 'adolescent risk behaviour' was coined, not by epidemiologists, but by behavioural scientists and developmental psychologists who viewed such behaviour within its social context and considered its social and developmental consequences. Jessor, for example, in his seminal work of 1991 argues that what adolescent risk behaviours put 'at risk' includes but goes beyond physical health and growth:

> *Risk behaviours can jeopardize the accomplishment of normal developmental tasks, the fulfilment of expected social roles, the acquisition of essential skills, the achievement of a sense of adequacy and competence, and the appropriate preparation for transition to the next stage in the life trajectory, young adulthood. The term risk behavior refers, then, to any behavior that can compromise these psychosocial aspects of adolescent development (Jessor 1991, p 599).*

Jessor's psychosocial definition of 'risk behaviour' inextricably links the concept to the social norms of the time. The concept of risk behaviour is therefore value-laden and (like the definition of adolescence itself) context-dependant. As critical theorists have pointed out, in public discourse 'risk' is not a neutral term but is value-laden, and functions as an instrument of social control (Lupton 1993, Peretti-Watel & Moatti 2006); '[T]he selection of risks deemed to be hazardous to a population is a social process: the risks that are selected may have no relation to real danger but are culturally identified as important' (Lupton, 1993 p428).

Although epidemiological discourse and public discourse are, to some extent, separate discursive domains (in which 'risk' holds different meanings), they undoubtedly influence one another. Hence, the term 'adolescent risk behaviour', when used in public health, is not morally neutral but contains within it the values and norms of the dominant culture as well as the epidemiological concept of risk.

It is important to note that dominant values and norms are not static or universal, and therefore what is perceived to be 'risky' (as opposed to normal or healthy) varies over time and between cultures. For example, in the dominant culture of the Western world, homosexuality is now considered a normal variation in human sexuality, and homosexual activity in adolescents above the age of consent (provided it is consensual and protected) is not seen as maladaptive or unhealthy from a public health or developmental perspective. However, it is only a few decades since homosexuality was considered a mental disorder, and homosexual activity was a crime. Homosexuality was only removed from the Diagnostic and Statistical Manual of Mental Disorders in 1973 (Drescher 2015), and it was not until 1986 that sexual relations between men aged 16 and over were decriminalised in New Zealand. This example demonstrates how the social – and scientific – definition of a behaviour can shift radically over just a few decades.

Furthermore there is historical and cultural variability in the age at which certain behaviours are considered appropriate and healthy. For example, in dominant public health discourse, 'teen pregnancy', is currently considered an important social and public health problem, since 'adolescent childbearing is associated with adverse outcomes for both teen mothers and their children'(Driscoll & Abma 2015). In the current literature 'teen' and 'adolescent' are often used interchangeably, and giving birth before the age of 20 is framed as problematic. Yet as recently as the 1970s it was statistically and culturally 'normal' to begin marriage and childbearing in one's late teens (e.g. in 1972 births to women aged less than 20 made up 14.5% of all births in New Zealand), and in medical terms this was seen as physiologically optimal (Wilson & Huntington 2005). At that time it was not teen pregnancy *per se*, but sexual activity and pregnancy *prior to marriage*, which was the primary focus of social and moral concern. Although there is consistent evidence that pregnancy in early adolescence (age 15 or younger) is associated with poorer maternal and child outcomes (Gibbs et al. 2012), there is little evidence that births to women aged 16 or over are 'risky' from a health perspective. The public health definition of a 'healthy' age for parenthood appears to have risen in line with social norms towards longer education and later childbearing in Western nations (and

concerns about 'welfare dependency') rather than based on evidence of elevated morbidity or mortality. Not only is current health discourse on teen pregnancy inconsistent with that of previous decades, but it is also at odds with Māori values (Pihama 2011), and with the views of young mothers themselves, who often frame early motherhood as a positive event in their own lives (Wilson & Huntington 2005).

Returning to Jessor's psychosocial definition of risk, it is important to note that risk behaviours are often subject to stigma or social sanctions, and negative consequences may result from these sanctions as much as (or more than) from the behaviour itself, with teenage motherhood an example. Cannabis use provides another example where negative consequences in the form of legal sanctions may be more serious than the health consequences of cannabis use itself (Wodak et al. 2002). Indeed, this is a key argument in public debates about decriminalising or legalising cannabis, which are currently underway in New Zealand and elsewhere.

In the discussion above, 'adolescent risk behaviour' is framed as *transgressive* – it is behaviour that is *outside* what is normal or expected, according to the dominant culture. However this conceptualisation can be contrasted with understandings of risk behaviour that highlight its normative and functional aspects. For example, as previously noted, experimentation with substance use and sex may play a functional role in meeting normal and healthy developmental goals of adolescence such as: independence, peer esteem, identity, and transition towards (perceived) adult roles.[2] Moffitt's theory of adolescence-limited antisocial behaviour emphasises that such behaviour is not statistically 'abnormal' but in fact very common, and although by definition antisocial behaviour (and 'risk behaviour') is transgressive, it is also typical of normal adolescent development (Moffitt 2006, de Looze et al. 2015c). Although Jessor frames risk behaviours as a 'syndrome' caused by underlying problems (e.g. with family relationships) rather than a normal part of growing up, he also acknowledges the instrumental functions they can play in an adolescent's life, and the normative nature of the goals they fulfil:

> *Considerable research has shown that adolescent risk behaviors are functional, purposive, instrumental, and goal-directed and that these goals are often central to normal adolescent development. Smoking, drinking, illicit drug use, risky driving, or*

[2] It is important to note that 'adolescent risk behaviours' differ in that some (e.g. moderate drinking; sexual intercourse) are acceptable in adults but deemed unacceptable/risky in adolescents, whereas others (e.g. cannabis use, petty crime) are unacceptable in people of *any* age in most jurisdictions. However, all may be *perceived* by young people to confer maturity (de Looze et al, 2015).

> *early sexual activity can be instrumental in gaining peer acceptance and respect; in establishing autonomy from parents … or in affirming maturity and marking a transition out of childhood and toward a more adult status (Jessor 1991, p 598).*

The conceptualisation of transgressive behaviour as a normal part of healthy development is not new. It is encapsulated in the Māori proverb translated as: 'It is the job of the children to smash the calabash'. The calabash was a valued item and can be seen as a metaphor for the rules and expectations of adult society. Māori recognised that it is in the nature of young people to play, explore, and transgress boundaries. This was not something to be punished, but rather it was seen as part the developmental work that young people must do on their journey to adulthood.

Within public health we tend to focus on potential harm, but efforts to reduce harm are likely to be unsuccessful (or have unintended consequences) if they are not cognisant of the developmental context for risk behaviours and the potential role they play in meeting normal and healthy developmental goals of adolescents. Jessor argues that, in order to be successful, interventions must provide alternative activities that allow adolescents to achieve these goals without the deleterious health and social effects of substance use, sexual risk taking and other risk behaviours.

Why are adolescent risk behaviours of public health concern?

Although definitions of 'adolescent risk behaviour' are strongly shaped by social norms, and such behaviours may help young people meet important developmental goals, they are not without real epidemiological risk. For example, it is now more than 50 years since the publication of the landmark Surgeon General's 'Smoking and Health' report in 1964 and the dangers of smoking are well known. An updated Surgeon General's review published in 2014 concludes that there is no safe level of exposure to tobacco smoke: 'All cigarettes are harmful, and any exposure to tobacco smoke can cause both immediate and long-term damage to the body' (Centers for Disease Control 2014). The harmfulness of smoking, coupled with the fact that nicotine is highly addictive, means that even occasional or experimental smoking in adolescents is of public health concern. Evidence indicates that smoking initiation at an early age predicts increased likelihood of dependence and decreased quitting success in adulthood, leading to greater risk of long-term harm (Breslau & Peterson 1996, Wiencke et al. 1999, Kendler et al. 2013).Thus smoking in childhood or early adolescence is of particular concern.

Cannabis smoke does not appear to have the intensely carcinogenic properties of tobacco smoke (Melamede 2005), however cannabis use is by no means harmless. It is associated with a range of adverse health impacts including acute risks e.g. accidental injury (Asbridge et al. 2012), and risks associated with long-term use e.g. cannabis dependence, dependence on other substances, and respiratory health problems (Volkow et al. 2014, Hall 2015). A growing body of evidence suggests that cannabis use also affects brain development and risk of mental illness and that use in adolescence is particularly harmful (Semple et al. 2005, Moore et al. 2007, Gobbi et al. 2019). Longitudinal research shows early age of initiation of cannabis use (<16 years of age), particularly in combination with alcohol and/or tobacco use, is associated with greater risk of poor educational outcomes, addiction, psychosis and other mental health problems and long-term functional impairment (Butterworth et al. 2014, Moss et al. 2014, Hall 2015, Patton 2016, Levine et al. 2017, Barthelemy et al. 2019, Gobbi et al. 2019). Furthermore, there is emerging evidence that regular cannabis use may encourage or maintain tobacco use (Patton et al. 2005, Wang et al. 2018), leading Patton et al to comment: 'It may be that a heightened risk of nicotine dependence is the most important health consequence of early frequent cannabis use' (Patton et al. 2005). Although the adverse consequences of cannabis use are most evident in heavy users, even occasional use in adolescence is associated with increased risk of psychosis and other harms (Arseneault et al. 2002, Moore et al. 2007). Therefore, preventing or delaying uptake of cannabis use is of public health importance.

Similarly, early age of onset of alcohol use is predictive of subsequent alcohol-related and psychosocial problems later in life, but there is growing evidence that age at first *intoxication* rather than age at first *drink* is a more useful predictor of harm (Newton-Howes et al. 2019). Acute alcohol harms (e.g. road crashes, injuries, violence, alcohol poisoning) account for a high proportion of adolescent morbidity and mortality globally (Mokdad et al. 2016). Thus adolescent alcohol use (particularly binge drinking) is associated with both long-term and immediate harms. New evidence suggests there may be no safe lower limit for consumption to avoid the risks associated with long-term alcohol use (Scoccianti et al. 2016, Wood et al. 2018).

Early substance use is consistently associated with long-term adverse outcomes, after adjustment for confounders, but whether this is a causal relationship continues to be debated. The association may be due to a 'critical period' in brain development during which substance use interferes with healthy development. This is supported by emerging findings from neuroscience indicating that use of alcohol and other drugs in childhood or early adolescence

affects the structure and function of the developing brain (Zalesky et al. 2012, Squeglia & Gray 2016). Another possibility is that the cumulative effects of use are greater in those who began substance use early in life. A further possibility is that residual confounding (e.g. childhood adversity) explains both early substance use and long-term adverse outcomes.

Although engaging in sexual intercourse below the age of legal consent is not necessarily harmful from a health perspective, early sexual initiation has been associated with greater likelihood of unprotected sex, both at first intercourse and in subsequent years (Finer & Philbin 2013, Lara & Abdo 2016). It is also associated with a higher number of sexual partners during adolescence and young adulthood (Heywood et al. 2015) and with an elevated risk of sexually transmitted infections (STIs) as a result (Kaestle et al. 2005). Due to immature cervical cells, younger women have a greater biological susceptibility to some STIs (e.g. chlamydia) compared with older women, and therefore condom use is particularly important during adolescence to protect against STIs (Kaestle et al. 2005). But despite the importance of access to condoms, those who become sexually active in early adolescence may have difficulty accessing sexual health services and contraception for a range of reasons, including social disapproval of underage sex. Young adolescents may also be more vulnerable to coercive sex, with implications for their emotional and mental health. For these reasons, underage sex is of public health concern.

The aetiology of adolescent risk behaviour

Understanding why and how risk behaviour arises is important if we want to understand why prevalence of risk behaviour might have declined since 2000. Since social science began, there has been scientific interest in the question of why adolescents engage in what we now call 'risk behaviour', and unsurprisingly, there are many theories and an enormous body of empirical work from a range of disciplines that address this question from multiple perspectives. What follows is a necessarily selective overview of relevant contemporary theory and evidence.

The biology of risk taking

So far, I have argued that adolescent risk behaviour is a profoundly *social* construct. However, based on the observation that risky behaviour in adolescence also occurs in other species (Blum et al. 2012), psychologists and neuroscientists have investigated the *biological* underpinnings of increased risk taking during the adolescent years. Early work focused on deficits in impulse control and judgement, based on neuroimaging showing that the pre-

frontal cortex (associated with executive function, complex reasoning and decision making) continued to mature well beyond the teenage years (Luciana 2013). These findings have since been challenged by alternative interpretations and new research (Steinberg 2008, Johnson et al. 2009, Romer et al. 2017), yet the idea that adolescents are biologically prone to impulsiveness and poor judgement remains dominant in public discourse despite ongoing scientific uncertainty and debate (Johnson et al. 2009).

Biological theories suggest that risk taking is inherent to the adolescent phase of life, but they cannot explain why certain risk behaviours rise and fall in prevalence over time. Examination of the social context and motivations for engaging in risk behaviours are more promising in that regard.

Social context

Qualitative research has highlighted the social meaning and functions that smoking, drinking and other risk behaviours perform in adolescents' lives. For example Haines et al (2009) conclude that:

> *[S]moking, drinking, [and] using drugs are much more than simple forms of teenage experimentation or rebellion, but can also serve as key resources for defining the self, acquiring status and making social distinctions within adolescent social worlds (Haines et al. 2009) p66.*

Thus these behaviours are embedded in young people's systems of meaning making: they are symbolic as well as material. For example, a New Zealand study conducted when adolescent smoking was at its peak in 1999 found that smoking was a key signifier of power and status among 13 and 14 year olds at that time (Plumridge et al. 2002). To be a non-smoker was to be socially positioned as 'average', thus 'presenting non-smoker adolescents with the problem of accrediting themselves against superior "smoker cool" groups' (p 167). Another New Zealand study highlighted the role of the alcohol industry in systems of meaning making, showed how alcohol brands and marketing materials had become integral to youth culture and identity (McCreanor et al. 2008). Pavis et al also highlight the role of 'symbolic consumption', including consumption of tobacco and alcohol, in British adolescents' careful construction of identity and choice of affiliations and lifestyle (Pavis et al. 1998). They argue that, while young people exercise agency and choice, they do so within the material and social constraints of the time and place in which they live. 'Structural and cultural factors both supply individuals with

meaning and choices and simultaneously constrain their perceptions and the options open to them' (p1417).

Motivations

An obvious way to investigate why young people engage in risk behaviour is to ask them. Survey findings on young people's motivation to smoke, drink or take drugs are very revealing. For example, a recent survey of English 11-15 year olds found that among those who smoked weekly or more often, 91% reported that people their age smoke to cope with stress, and 84% reported that adolescents smoke because they are addicted (NHS Digital 2017). The same survey found that, among past week drinkers, key beliefs about why people their own age drink alcohol were: to get a rush or a buzz (86%); to be more sociable (78%); to feel more confident (74%); and to forget their problems (57%). When asked about their own motivations for drug use, the most common reason for trying drugs for the first time was curiosity (63%); while 'getting high or feeling good' (41%) was the most common reason given for their most recent drug use. Fourteen percent reported the reason for their most recent drug use was to forget their problems (NHS Digital 2017).

US research into the reasons secondary school students use cannabis also found that social and recreational reasons predominated. However a substantial minority used cannabis to escape problems, deal with negative emotions or relax. Importantly, they found that the proportion of students reporting 'coping' motivations increased substantially between 1976 and 2016 (Patrick et al. 2019). For example, the proportion who used cannabis to 'escape problems' rose steadily from 18% to 31%. Thus it appears that, for the majority of young people, experimentation, pleasure seeking and sociability are the main reasons for using alcohol and psychoactive drugs, but for a substantial and growing minority (at least in the USA) these substances are used as a coping strategy. In contrast, smoking is rarely pleasure-driven and is almost always motived by addiction or a desire to cope with stress, according to young people's reports.

A body of research shows coping motivation is associated with more frequent and heavy substance use, and greater risk of dependency and substance use problems (Patrick et al. 2019). Furthermore risk factors for early onset, extreme, or multiple risk behaviours appear to be different than for moderate/experimental risk behaviours. For example, factors predicting heavy or multiple substance use and early initiation of sex and substance use include: childhood adversity including neglect and sexual abuse, witnessing or experiencing violence,

poor quality of family relationships, school failure, hopelessness, and psychological distress (Rothman et al. 2008, Malmberg et al. 2010, James et al. 2012, Fleming et al. 2014). Rothman found that those experiencing childhood adversity were more likely to report that drinking was used as a means of coping during their first year of alcohol use (Rothman et al. 2008). Thus the aetiology and consequences of 'coping' motivated risk behaviour may be distinct from that of risk behaviour motivated by pleasure seeking and sociability.

Life-course-persistent and adolescent-limited antisocial behaviour

Criminologist Terrie Moffitt divides adolescent anti-social behaviour in into two types based on the findings of the Dunedin longitudinal study[3] and subsequent research (Moffitt 2006). The first is 'life-course-persistent' which develops early in life (i.e. prior to adolescence) and continues into adult life in a small proportion of individuals. According to Moffitt's theory, this persistent pattern of behaviour is due to inherited or acquired pre-disposing traits (e.g. cognitive deficits, impulsiveness, aggression) that are exacerbated by a high risk environment (e.g. inadequate parenting, poverty). The second type is 'adolescent-limited anti-social behaviour' which is more common and arises in otherwise healthy young people during the adolescent years. Moffitt posits that this is due the 'maturity gap' between puberty and achievement of adult roles, leading to 'role-lessness' and 'dissatisfaction with their dependent status as a child and impatience for what they anticipate are the privileges and rights of adulthood' (p571). She argues that anti-social behaviours fulfil a desire for autonomy and allow young people to assert their maturity through engagement in 'adult-like' behaviours. Adolescent-limited anti-social behaviour is usually quickly extinguished when adult roles are achieved. But this 'recovery' from risk behaviour can be delayed if risk taking results in a criminal record, addiction, or poor educational outcomes, and therefore even young people without predisposing traits or adverse backgrounds may suffer lifelong consequences of adolescent risk-taking. According to Moffitt's theory, the anti-social behaviour displayed during adolescence may be similar in both sub-types, but the life-course-persistent pattern has its origins in neurodevelopmental processes, whereas adolescence-limited anti-social behaviour has its origins in social processes (Moffitt 2006).

Because of their differing aetiologies, we would expect different explanations for declines in different subtypes of risk behaviour. For example, declines in 'coping' motivated and 'life-

[3] The Dunedin study is a study of the health, development and wellbeing of a cohort of approximately 1000 people, born in 1972-73 in the city of Dunedin, New Zealand.

course-persistent' risk behaviour might be underpinned by improved parenting and declining rates of poverty, child maltreatment and other stressors. In contrast, the prevalence of risk behaviours motivated by desire for fun and sociability might be more responsive to changes in peer norms and the social acceptability of those behaviours.

Resilience

Moffitt's theory regarding life-course-persistent anti-social behaviour is supported by recent advances in neuroscience and epigenetics that suggest early life adversity can affect the biology of an individual and have lifelong impacts on personality, behaviour, and how a person interacts with the world (Keating 2017). However, not all young people exposed to adversity or trauma in early life go on to have lifelong problems; research shows there is considerable individual variation in how children respond to stressors and many 'at risk' children go on to have good outcomes (Rutter 1985). This observation led to the emergence of 'resilience' research from the 1970s concerned with identifying factors associated with 'normal development under difficult conditions' (Fonagy et al. 1994). As Moffitt's theory suggests, individual traits and personality factors play an important role, as well as other assets and resources in the social environment (Zolkoski & Bullock 2012). These protective factors are discussed below, alongside risk and protective factors identified in other public health and prevention science research.

Factors associated with many risk behaviours

Within public health, the 'ecological perspective' emphasises the multiple levels of influence on health and health behaviour: individual, interpersonal, community, and public policy (Rimer & Glanz 2005). A large body of empirical research has identified risk and protective factors at these various levels associated with increased or decreased likelihood of an individual engaging in risk behaviours in adolescence. While some risk/protective factors are specific to a particular behaviour (e.g. tobacco price, sex education), there is evidence that others (e.g. impulse control, parental monitoring, connectedness to school, and neighbourhood deprivation) are correlated with a wide range of risk behaviours in young people (Blum 1998). Some of these 'shared' risk and protective factors, associated with many risk behaviours, are summarised in Table 1. Factors associated with an increased likelihood of risk behaviour are marked R (for risk), and those associated with decreased likelihood of risk behaviour are marked P (for protective).

Table 1: Shared risk/protective factors associated with many risk behaviours

	Proximal	**Distal**
Individual	Self-regulation (P)/impulsiveness (R) Risk preference/sensation seeking (R) Income/spending money (R)	Academic achievement & aspirations (P) Future orientation/Hope for the future (P) Self-efficacy (P) Early pubertal timing (R) Psychological wellbeing(P)/distress (R)
Interpersonal	Time spent with peers (R) Frequency of going out in the evening (R) Peer/sibling substance use (R) Behaviour problems in early childhood (R)	Strong attachment to a caregiver in the first year of life (P) Child abuse/neglect/sexual abuse (historical or current) (R) Witnessing violence at home (R) Parental mental illness/addictions (R) Family attachment/Quality of relationship with parents/Time spent with family (P) Authoritative parenting style (P)/Parental monitoring (P) Low parental education level (R) Low family socio-economic position (R) Family structure Connectedness to school (P) Connectedness with adults outside the immediate family (P) Frequent electronic communication with peers (R)
Community	School-level norms re disapproval of risk behaviour (P)	School environment/ethos Religious involvement (P) Participation in supervised community volunteering (P) Neighbourhood attachment (P) Experience of racism (R)

	Proximal	**Distal**
		Residential mobility (R) Neighbourhood-level deprivation/disorganisation (R)
Public policy		Poverty (R) Income inequality (R) Comprehensive prevention programmes addressing individual, peer, family, school and community domains (P) Whole-school interventions (P) School-based social and emotional learning/life skills education (P)

As illustrated in Table 1, the majority of these 'shared' factors are distal, meaning they exert their effects via other more proximal factors. Although causality is not certain, and causal pathways are still being investigated, the evidence for the importance and consistency of these predictors is based on a large body of cross-sectional, longitudinal and intervention research conducted over more than 40 years. These studies have included a wide range of populations and settings in high-income countries. Key studies and reviews include: (Hawkins et al. 1992, Resnick et al. 1997, Blum 1998, Jessor et al. 1998, Kumar et al. 2002, Barnett et al. 2004, Loxley et al. 2004, Kokkevi et al. 2007, Newman et al. 2008, Sigfusdottir et al. 2009, Hahm et al. 2010, Malmberg et al. 2010, Hale & Viner 2012, Jackson et al. 2012a, Shonkoff et al. 2012, Viner et al. 2012, Zolkoski & Bullock 2012, Bradley & Greene 2013, Jamal et al. 2013, Patrick & Schulenberg 2013, Johnson et al. 2014, de Looze et al. 2015c, Gommans et al. 2015, Keyes et al. 2015, White et al. 2015a, Carver et al. 2016, Shackleton et al. 2016, Whitehead et al. 2016).

Evaluations of programmes aimed at preventing risk behaviours and promoting positive youth development have mixed findings. Evidence suggests that changes in school ethos (Bonell et al. 2007) and increased focus on social and emotional learning (Durlak et al. 2011), for example, can positively influence a range of behaviours at the school level. The most promising interventions are those that address risk and protective factors in multiple domains including individual, family, school and community (Sigfusdottir et al. 2011, Jackson et al.

2012a). Common predictors in home, school and leisure settings, including discussion of possible causal pathways, are discussed further in the introduction to Chapter 6.

Behaviour-specific risk and protective factors

Within the fields of tobacco control, alcohol and drug research and sexual and reproductive health, the identification of behaviour-specific risk and protective factors relevant to those fields has been a key focus of research. Behaviour-specific risk and protective factors for adolescent smoking, cannabis use and under-age/unprotected sex are summarised in Tables 2 to 5 below.

Table 2: Tobacco-specific risk and protective factors for adolescent smoking

Tobacco smoking	Proximal	Distal
Individual	Smoking-related attitudes and beliefs, e.g. perceived harmfulness, disapproval(P) Alcohol and/or cannabis use (R)	Negative affect/psychological distress/depression (R) Exposure to smoking in movies and other media (R) Mobile phone/internet/social media use (R)
Interpersonal	Parental/social supply of tobacco (R) Smoking-specific parenting rules, expectations, practices (P) Exposure to secondhand smoke(R) Peer/sibling smoking (R)	Parental smoking (R)
Community		School/community smoking prevalence Country/state-level social attitudes to smoking
Public policy	Price/affordability of tobacco Availability of self-service/tobacco vending machines (R) Availability of tobacco (R)	Exposure to anti-tobacco advertising (P) Exposure to tobacco marketing (R) Strength of tobacco control policy at the state/country level (P) Enforcement of tobacco regulations (e.g. underage retail sales) (P)

There is wide agreement in the literature that tobacco-specific factors (Table 2), in particular proximal peer, family and attitudinal factors, are among the most important predictors of adolescent smoking (Tyas & Pederson 1998, Avenevoli & Merikangas 2003, Ennett et al. 2010, Waa et al. 2011, Centers for Disease Control 2012, Ball et al. 2018a). The association between psychological distress and adolescent smoking is also well researched, with evidence of a bi-directional relationship (Tyas & Pederson 1998, Chaiton et al. 2009). Engagement in other risk behaviours, particularly alcohol and cannabis use, predicts onset and persistence of adolescent smoking (Patton et al. 2005, Bailey et al. 2009, Leatherdale & Ahmed 2010, Agrawal et al. 2012, Moss et al. 2014). The clustering of adolescent risk behaviours is discussed further below.

Research in a range of settings has found a positive correlation between digital media use and smoking in adolescents (Iannotti et al. 2009, Huang et al. 2012, Morioka et al. 2016). That is, frequent or heavy users of the internet, social media and mobile phones are more likely to smoke than those less engaged in digital media.

Research definitively linking community and policy factors with adolescent smoking is limited, but there is some evidence that school and neighbourhood smoking prevalence (Ennett et al. 2010) and policy interventions such as tobacco taxation, smokefree policies, mass mediacampaigns and enforcement of retail regulations can influence adolescent smoking (White et al. 2008, DiFranza et al. 2009, White et al. 2011, White et al. 2015b, Cavazos-Rehg et al. 2016). However, the findings of policy evaluations are mixed, with many studies failing to detect any impact on adolescent smoking at the population level (Bogdanovica et al. 2017, Kuipers et al. 2017, Manivong et al. 2017). Furthermore, at the national level, adolescent smoking prevalence varies widely but the variation is not well explained by tobacco control policies (Hublet et al. 2009, Pförtner et al. 2016).

Smoking is strongly patterned by socio-economic status and ethnicity, and qualitative research provides a nuanced understanding of the contexts of smoking uptake and the role smoking plays in the lives and identity of disadvantaged, ethnic minority and Indigenous youth (Gifford 2003, Hefler & Chapman 2015, Delaney et al. 2018). Qualitative research also reveals that, although smoking prevalence is now generally similar in adolescent boys and girls in most high-income countries, the function and meaning of smoking (and non-smoking) may differ by gender (Daykin 1993, Plumridge et al. 2002).

Table 3: Cannabis-specific risk and protective factors for adolescent cannabis use

	Proximal	**Distal**
Individual	Attitudes and beliefs about cannabis e.g. perceived risk, disapproval (P) Early tobacco and alcohol use(R)	Conduct disorder/aggression (R) Male gender (R)
Interpersonal	Peer cannabis use (R)	Parental cannabis use (R) Parental attitudes favourable to drug use (R)
Community	Availability of cannabis (R)	Neighbourhood crime (R) Social disapproval of cannabis use (P)

The majority of research on cannabis use in adolescents has focused on consequences rather than predictors of use, but nevertheless there is a body of research that identifies cannabis-specific risk factors (Table 3). Key predictors (in addition to the shared factors in Table 1) include peer cannabis use, attitudes favourable to cannabis use, and the perception that cannabis is widely used and harmless (Olds et al. 2005, Fleming et al. 2016, Miech et al. 2017, Defoe et al. 2019). Another important risk factor is early use of tobacco and/or alcohol, which predicts subsequent cannabis use (Agrawal et al. 2006, Agrawal et al. 2012, Butterworth et al. 2014, Badiani et al. 2015, Keyes et al. 2016). Conduct disorder and/or aggression in childhood is a predictor for substance use of all kinds, but particularly cannabis and poly-drug use (Loxley et al. 2004, Defoe et al. 2019).

Cannabis use is markedly more common in adolescent boys than girls in most high-income countries, and qualitative research suggests that male cannabis users value the role cannabis can play in initiating and maintaining male friendship groups during adolescence (Lamb 2011). Although evidence is scarce, the function and symbolic meaning of adolescent cannabis use may differ by gender, informed by masculine and feminine gender roles (Mahalik et al. 2015, Hawes et al. 2019).

Parental cannabis use is a predictor of adolescent cannabis use, but the mechanisms by which cannabis use is transmitted to the next generation are not well understood (Sternberg et al. 2019). Cannabis-specific parental strategies intended to deter cannabis use (e.g. sharing

negative experiences) have been shown to be ineffective and may even increase likelihood of adolescent cannabis use (Sternberg et al. 2019). Although evidence is scarce, community level factors may also play a role in the uptake of cannabis use. For example, neighbourhood crime was found to be significantly associated with cannabis use in 14-15 year olds in Canada, independent of socio-economic status, peer use of cannabis, parental factors and other potential confounders (de Looze et al. 2015a). A US study found that social disapproval of cannabis was negatively correlated with adolescent use, independent of personal attitudes (Keyes et al. 2011).

There has been considerable research on the impact of cannabis decriminalisation and legalisation in the USA in recent years. Research has found no association between decriminalisation or legalisation of cannabis and adolescent cannabis use at the state level (Choo et al. 2014, Carliner et al. 2017, Grucza et al. 2018b, Hasin 2018). Although there has been a steep rise in cannabis use in adults (including the 18-24 age group) in the USA since 2005, this appears to be a period effect across the country as a whole and is not specifically linked to cannabis liberalisation in certain states (Grucza et al. 2018a). Thus the legal status of cannabis does not appear to be a determinant of cannabis use for adolescents or adults. It is possible that normalisation of cannabis use (related to legalisation but not limited to those states in which legalisation has occurred) has been a contributing factor to the rise in cannabis use in young adults, however I am not aware of any empirical work that has tested this hypothesis.

Table 4: Alcohol-specific risk and protective factors for early initiation/binge drinking

	Proximal	**Distal**
Individual	Alcohol related attitudes and beliefs favourable to drinking (R) Awareness of alcohol-related harm (P) Other risk behaviours, particularly smoking (R)	Time spent on the internet (R) Exposure to drinking scenes in movies, on TV and other media (R) Exposure to alcohol marketing (R)
Interpersonal	Peer drinking (R) Alcohol-specific parental rules, expectations & attitudes unfavourable to adolescent drinking (P) Parental supply of alcohol/approval of	Popularity (R) Parental drinking, in particular binge drinking (R)

	Proximal	**Distal**
	adolescent drinking (R)	
Community	Ease of access to alcohol (R)	Social attitudes towards alcohol Density of liquor retailers (R)
Public policy		Presence and enforcement of minimum purchase age regulations (P) Restrictive policy environment (P)

Alcohol-specific risk and protective factors are set out in Table 4. As for other substances, peer use, and attitudes to alcohol use are among the strongest predictors of early initiation and adolescent binge drinking, along with alcohol-specific parenting factors (Ryan et al. 2010, Patrick & Schulenberg 2013, Carter et al. 2017, Yap et al. 2017). Alcohol-specific parenting factors (e.g. parental drinking, approval/disapproval of adolescent drinking, rule setting and facilitation/restriction of adolescent access to alcohol) appear to be more important than generic parenting factors (e.g. parental monitoring, quality of parent-child relationship) in preventing early and/or heavy use of alcohol in adolescents (Long Foley et al. 2004, Van Zundert et al. 2006, Koning et al. 2014, Mattick et al. 2017, Pape & Bye 2017).

Media exposure, including time spent on the internet, is consistently associated with elevated risk of early alcohol initiation and binge drinking (Chiao et al. 2014, Mu et al. 2015) which may be mediated by exposure to depictions of alcohol use and/or alcohol marketing (Anderson et al. 2009, Nunez-Smith et al. 2010). Popularity is associated with alcohol use (Gommans et al. 2016), which may reflect the cultural role of alcohol in social life in high-income Western countries. It is also consistent with qualitative findings that risk behaviours can function to enhance or maintain an individual's social status within his or her peer group.

Although gender differences in the prevalence of adolescents' alcohol use and binge drinking (at the 5+ drink threshold) are generally not pronounced in high-income Western countries, very heavy drinking (10+, 15+ or 20+ drinks in a session) and alcohol-related harm are more

common in males (Livingston et al. 2008, Patrick et al. 2013). This may reflect gender roles, and the social meaning of heavy drinking as a symbol of masculinity or a rite of passage into manhood in some societies (Mahalik et al. 2015).

Density of liquor outlets is consistently associated with youth alcohol consumption and harm (Huckle et al. 2008, Livingston et al. 2008). There is evidence that raising or lowering the minimum alcohol purchase age influences the prevalence of adolescent drinking (Coate & Grossman 1988, Gruenewald et al. 2015), but findings in relation to other policy interventions are mixed (Muller et al. 2010, Cavazos-Rehg et al. 2012, Gilligan et al. 2012, Lintonen et al. 2013, Lensvelt et al. 2016, White et al. 2018). Ease of access to alcohol is an important predictor of adolescent drinking. However, adolescents generally access alcohol from family or friends rather than purchasing it themselves, which may explain the apparently limited effects of specific policies aimed at restricting youth access to alcohol (Paschall et al. 2007, Treno et al. 2008). Nonetheless, strengthening of restrictive alcohol policy is generally associated with declining adolescent drinking, whereas relaxation of the policy environment is typically associated with an increase in youth drinking (Huckle et al. 2006, Huckle et al. 2012, White et al. 2018).

Table 5: Behaviour-specific risk and protective factors for under-age and unprotected sex

	Proximal	**Distal**
Individual	Other risk behaviours, especially binge drinking (R) Attitudes, beliefs and skills relating to sex and condom use (P) AIDS-specific self-efficacy (P) Sexual health and contraception knowledge (P)	Born to a teenage mother (R) Father absence (girls) (R)
Interpersonal	Sexually active peers (R)	Having an older boyfriend/girlfriend (R) Low maternal education (R)
Community		Social attitudes towards adolescent sexuality

Public policy	School-based access to condoms (P)	Comprehensive, high quality sex education (P) Alcohol-related policy e.g. taxation, strict drink-driving policies (P) Access to high quality school-based health services (P)

The body of research documenting predictors of early or unprotected sex among adolescents is smaller than that for substance use, but a number of behaviour-specific factors can be identified (Table 5). For example, for girls, being born to a teenage mother is predictive of early sexual debut (Paul et al. 2000, Manlove et al. 2009). For both boys and girls sexuality-related attitudinal and peer factors are important (Kotchick et al. 2001, Kirby 2013). Having an older boyfriend or girlfriend is associated with early sexual debut in both boys and girls and decreased likelihood of contraception use in girls (Manlove et al. 2009).

Socioeconomic disadvantage, experience of sexual abuse, disengagement from school, family breakdown and lack of close family relationships are risk factors for risk behaviours of all kinds, but appear to be particularly strongly associated with early sexual debut, as is early puberty (Paul et al. 2000, Kotchick et al. 2001, Ellis et al. 2003, Huebner & Howell 2003, James et al. 2012). Evidence suggests generic protective factors such as academic aspirations, community participation and pro-social peers may be particularly important for the prevention of sexual risk behaviour (Hodder et al. 2018).

Other risk behaviours, in particular binge drinking, are consistently associated with early sexual debut and unprotected sex (Valois et al. 1999, George & Stoner 2000, Paul et al. 2000, Kotchick et al. 2001, Aicken et al. 2011, Ritchwood et al. 2015). There is some evidence that policy measures aimed at reducing adolescent binge drinking and drunk driving (e.g. taxation, zero blood alcohol policies for young drivers) have reduced sexually transmitted infection rates, at least among young men in parts of the USA (Chesson et al. 2000, Carpenter 2005).

School-based access to condoms, and comprehensive, high quality sex education are other policy level factors that have been shown to reduce sexual risk taking in adolescents in some studies (Kirby 2013). However evidence of the effectiveness of sex education and interventions to improve access to contraception is mixed (Girma & Paton 2015). A related factor is the nature of social attitudes towards adolescent sexuality. There is evidence that in

countries where adolescent sexuality is accepted and discussed openly in society, adolescent sexual risk taking tends to be lower than in countries where discussion of sexuality – in particular adolescent sexuality – is taboo (Schalet 2011).

Interactions

It is important to note that factors at different levels and in different settings may *interact* to influence risk behaviour, for example protective factors in one setting (e.g. school) may counteract risk factors in another setting (e.g. home) (Mayberry et al. 2009). Factors may also amplify one another over time in virtuous or vicious cycles, and may interact in complex ways.

Differences by subgroup and social patterning

It is also important to note that different demographic groups may differ with respect to key risk and protective factors. In particular, differing risk factors may be more salient at different ages. For example there is consistent evidence that higher tobacco prices are strongly protective against smoking in older adolescents and young adults but evidence is mixed regarding the impact of price on younger adolescents (Gruber & Zinman 2001, Pampel & Aguilar 2008, Chaloupka et al. 2012, Cavazos-Rehg et al. 2016, Manivong et al. 2017). A US study suggests that family and community factors are more salient among younger adolescents, while peer and school factors are stronger predictors among older adolescents (Cleveland et al. 2008, Van Ryzin et al. 2012).

Demographic groups may also differ in terms of *exposure* to risk and protective factors, giving rise to social patterning in risk behaviour prevalence. For example, young people in ethnic minorities and low socio-economic groups tend to have greater exposure to risk factors due to structural disadvantage. In New Zealand, Australia, the USA and England, these structural disadvantages are rooted in historical and contemporary injustices of colonialism, white supremacy, and the class system (Graham et al. 2006, King et al. 2009, Graham 2011). As a result, risk behaviours tend to be more prevalent in disadvantaged groups, with a 'social gradient' often apparent.

Clustering of risk behaviours

It is well established that risk behaviours are highly correlated, and findings of longitudinal studies show that participation in one is associated with greater likelihood of engaging in others (Agrawal et al. 2006). Some studies emphasise the primacy of alcohol use as a precursor to use of other substances (Jackson et al. 2002, Leatherdale & Ahmed 2010, Barry et al. 2016), sexual risk taking (George & Stoner 2000, Aicken et al. 2011) or other risk

behaviours. For example, a US study found a dose-response relationship between frequency of binge drinking and likelihood of other risk behaviours such as smoking, illicit drug use, sexual activity and riding in a car with a driver who had been drinking (Miller et al. 2007). Other studies suggest that early tobacco use is a particularly strong predictor of subsequent risk behaviour in longitudinal analyses (DuRant et al. 1999, Van Ryzin et al. 2012, Keyes et al. 2016). For example a recent US study shows that about three quarters of adolescents who try smoking will use cannabis in the same or a later grade of secondary school (Keyes et al. 2018).

There is continuing scientific debate about whether the clustering of substance use behaviours is causal (often called the 'gateway' hypothesis) or due to common liability (i.e. genetic or environmental factors that make individuals vulnerable to substance use in general). Proponents of the gateway hypothesis have observed that, among problematic drug users, substance use typically follows a sequence from alcohol and tobacco, to cannabis, and subsequently to 'hard' drugs. They argue that possible causal mechanisms include peer selection and neurological priming (Kandel & Kandel 2014, Kandel & Kandel 2015, Miller & Hurd 2017). However, an alternative explanation for the sequencing of substance use is that the order is opportunistic, with the most available and socially acceptable substances the first to be used (Vanyukov et al. 2012). This is supported by a recent study showing that cannabis is now the first substance used by the majority of secondary school students in the USA (i.e. before tobacco or alcohol). It is likely that this reflects a decline in the social acceptability and availability of tobacco and alcohol in this age group (Keyes et al. 2018).

Recent research has demonstrated 'reverse gateways' from cannabis use to smoking (Hall & Lynskey 2005, Patton et al. 2005), and reciprocal relationships between alcohol, tobacco and cannabis use, whereby onset and persistence of one is predicted by prior use of another (Jackson et al. 2002, Patton et al. 2005, Webster et al. 2014, Badiani et al. 2015). These studies do not necessarily 'disprove' the gateway hypothesis but they do suggest that the relationships between substance use behaviours are complex and that causality (if it is present) is often bi-directional.

On the basis of existing evidence it seems plausible that the strong relationships between risk behaviours have both causal and common liability elements. As previously discussed there are a range of shared risk factors common to many or all risk behaviours which may partially account for clustering, along with the common symbolic function that risk behaviours appear to play in adolescents' lives (Moffitt 2006, de Looze et al. 2015c). There are also plausible causal mechanisms that could underlie the associations between risk behaviours. For

example, engagement in one risk behaviour may provide entry into social settings or networks in which opportunities for other risk behaviours arise; enjoyment of one substance may pique curiosity about others; binge drinking (or use of other psychoactive substances) may lower inhibitions, making sexual activity and other risk behaviours more likely. Furthermore some substances tend to be consumed together by social convention (e.g. tobacco and cannabis; alcohol and tobacco) leading to complementarity i.e. a change in demand for one results in a corresponding change in demand for the other (Dee 1999, Agrawal et al. 2012).

Conclusion

In summary, neither the experience of adolescence nor the concept of adolescent risk behaviour are universal or immutable but are socially constructed and historically and culturally specific. Furthermore, adolescent risk behaviours can be seen as *both* functional from a developmental perspective *and* potentially harmful. These insights have important implications for my doctoral project. Firstly, adolescent behaviours cannot be studied in isolation from the social and developmental context in which they occur (Crockett 1997, Gielen & Roopnarine 2016), and therefore my project must attend to the social and historical context and changes of recent decades, and the developmental tasks of adolescence. Secondly, study of adolescent risk behaviours is never 'value free' and therefore critical reflection on the values and power relations underpinning my own and others' research is needed. Definitions of 'adolescent risk behaviour' reflect the values and norms of the dominant culture and may serve to pathologise non-dominant groups who hold different values and norms, so must not be adopted uncritically.

This chapter has not only laid the theoretical foundation for my thesis, but also discussed the changing social context, the aetiology of adolescent risk behaviour, and the determinants of adolescent smoking, drinking, cannabis use and underage or unprotected sex. The picture is complex, but already some clues are emerging as to the possible drivers of the decline in adolescent risk behaviour. Based on analysis of the changing context, hypotheses for declining adolescent risk behaviour could include:

- older and more educated parents who are more protective, supportive and involved in their adolescents' lives
- greater societal focus on prevention/safety
- greater awareness among parents and teens of the harms of substance use
- pressure on adolescents to prepare for a competitive job market

- fewer opportunities for young people to gather due to exclusion of young people from public space and more protective parenting
- shift in time use towards screen based socialising/entertainment and displacement of other activities including risk behaviours; and
- emergence of cyberspace as a location to express identity, engage in status-enhancing activities, and produce/consume youth culture.

These themes will be picked up again in the following chapters. Chapter 3 provides a descriptive analysis of risk behaviours trends, and discussion of what the observed patterns suggest about the drivers of risk behaviour decline, and Chapter 4 reviews literature explicitly aimed at understanding why risk behaviour has declined.

CHAPTER 3: DESCRIPTIVE ANALYSIS OF TRENDS

Moral panics about youth behaviour are a historical constant,

but now they are especially unmoored from reality

(Malcom Harris 'Kids these days' 2017 p.188)

Introduction

Media coverage, and even academic textbooks, often give the impression that adolescent behaviour has become increasingly problematic with every passing year.[4] But recent evidence suggests a very different picture.

This chapter describes a seismic shift in adolescent behaviour, international in scope and encompassing a wide range of risk behaviours. It draws together existing trend data on prevalence of risk behaviours in New Zealand, Australia, USA and England over the 1990-2017 period, with a particular focus on smoking, drinking, cannabis use and sexual behaviour.

As outlined in the introduction, my focus is particularly on younger adolescents (aged less than 16) since early initiation of risk behaviours is associated with greater risk of harm. Unless otherwise specified, the term 'adolescent' refers to this early- to mid-adolescent age group. For each risk behaviour the aim is to address the following questions:

- How has prevalence changed since 1990 in the countries of interest?
- Are trends similar in all demographic groups (by gender, SES and ethnicity)?
- Are trends similar to or distinct from adult trends?
- Are trends similar in other high income countries?

To explore the breadth of the shift in adolescent behaviours and indicators, trends in adolescent traffic fatalities, crime and delinquency, nutrition and obesity, physical activity and mental health are also briefly touched on. By observing patterns in the timing and distribution of adolescent behaviour changes, we may find some clues as to the possible drivers.

[4] For example, the first chapter of the 2013 *Handbook of Adolescent Risk Behaviour* (entitled 'A Generation in Jeopardy') states: 'Trends indicate that adolescent risk behaviors may become increasingly problematic in the future. The initiation of risky behaviors is occurring at progressively younger ages'. It concludes: 'As a society we are now faced with what can appropriately be referred to as an adolescent "risk behavior epidemic"'. DiClemente, RJ, Hansen, WB & Ponton, LE, Eds. (2013). Handbook of Adolescent Health Risk Behavior. New York, Springer Science & Business Media, p2-3.

Methods

Data sources

I have sourced nationally-representative data from the four countries of interest, and where more than one source was available I have prioritised according to a) sample size, b) survey frequency/coverage of the study period, c) consistency of survey methodology over time, and d) availability of data tables in the public domain. Key data sources are described below.

USA: Monitoring the Future (MTF) has been conducted by the University of Michigan since 1975 to monitor tobacco, alcohol and illicit drug use in 12th graders (17-18 year olds). Since 1991 the survey has been conducted annually, and includes grade 8 (13-14 year olds) and grade 10 (15-16 year olds), as well as grade 12, with a nationally representative sample of over 40,000 per year (16,000-18,000 in each grade). Detailed data tables from 1991 are available in the public domain, showing lifetime, annual, 30-day and daily prevalence of tobacco, alcohol and illicit drugs. The survey also tracks key attitudinal factors such as perceived risk and acceptability of the various substances. Details on the study design and methods for this survey have been published elsewhere (Johnston et al. 2016).

USA: Youth Risk Behaviour Survey (YRBS) monitors a range of health risk behaviours including sexual behaviour among 9th-12th graders (aged 14-18 years). It has been conducted by the Centers for Disease Control every two years since 1991, and provides nationally representative data based on an annual sample of approximately 16,000. Details on the study design and methods for this survey have been published elsewhere (Brener et al. 2013).

Australia: Australian Secondary Students Alcohol and Drug Survey (ASSAD) has been conducted every three years since 1984 to monitor alcohol and tobacco use, with additional questions on illicit drugs added from 1996. Nationally, the survey is coordinated by Cancer Council Victoria's Centre for Behavioural Research in Cancer (CBRC), and analysis is routinely conducted separately for 12-15 year olds and 16-17 year olds. It is a nationally-representative survey with an annual sample size of over 30,000 secondary school students. Data tables are not available in the public domain, but have been supplied by CBRC on request.

Australia: National Survey of Australian Secondary Students and Sexual Health (NSASSSH), has been conducted by La Trobe University in 1992, 1997, 2002, 2008, and 2014. The 2014 survey involved years 10, 11 and 12, (aged 15-18 years) whereas previous surveys sampled year 10 and 12 students only. The annual sample size was 1,700-3,600. School response rates have gone down considerably over time (from 68% in 1997 to 26% in 2008) and due to

methodological challenges, the 2014 survey is not nationally representative. Prior to 2014, data were weighted to provide nationally representative estimates.

England: Smoking, Drinking and Drug Use among Young People in England (SDD) is a school-based survey of adolescents aged 11-15 which has been monitoring tobacco use since 1982, alcohol use from 1988 and has included illicit drugs since 2001. The survey was run two-yearly until 1998, then was conducted annually until 2014, after which a two-yearly pattern resumed. The sample size is approximately 6,000-10,000 per year. The survey is commissioned and managed by the Health and Social Care Information Centre of the NHS.

England: Health Behaviour in School-aged Children (HBSC) is a cross-national study that monitors a wide range of health behaviours, including sexual behaviour. It has used a standardised set of 'core' questions since 2002. England has been represented in the last four survey cycles (since 1997), with an annual sample of approximately 5000 young people aged 11-15, with at least 1,500 in each of three age groups: 11, 13, and 15.

New Zealand: ASH Year 10 Snapshot Survey is an annual census-style survey of Year 10 students (aged 14-15 years) focusing on tobacco use. It has been conducted since 1999, with over 20,000 respondents each year (roughly half of the nation's Year 10 students), and was preceded by national surveys in 1992, 1997 and 1998 that used broadly comparable methods albeit with smaller sample sizes of approximately 10,000 per year. Data for 1992, 1997 and 1998 has been drawn from a peer-reviewed publication of findings (Laugesen & Scragg 2000). Details of the study design and methods have been published elsewhere (ASH 2014).

New Zealand: Youth 2000 series, administered by the Adolescent Health Research Group at the University of Auckland, surveyed secondary students in 2001, 2007 and 2012 on a wide range of health behaviours including tobacco, alcohol and drug use, and sexual behaviour. Each survey had a sample size of at least 8,500, and was administered via a computer-based self-administered questionnaire. Further methodological details are available elsewhere (Adolescent Health Research Group 2013).

These nationally representative surveys have been designed with the aim of detecting trends over time, and (with the exception of the Australian National Sexual Health Survey) consistency of questions and methods over the study period means comparability between years is adequate. Where this is not the case, only comparable data is shown, e.g. question wording around alcohol use changed for the 2016 SDD survey, and therefore 2016 data points have not been included in the charts below because they are not comparable with previous

years. It is notable that data quality and availability for sexual behaviour is much lower than that for substance use.

With the exception of tobacco use, New Zealand has relatively poor long-term surveillance data on adolescent risk behaviours compared with the other countries of interest. For example the only nationally representative data source for long-term trends in alcohol use, cannabis use and sexual behaviour in secondary school students is the Youth 2000 series (2001, 2007 and 2012) described above. The Youth Insights Survey, conducted by the Health Promotion Agency every two years since 2006 to monitor smoking-related knowledge, attitudes, and behaviour, has included questions on alcohol and cannabis use since 2012. However the Youth Insights Survey is restricted to Year 10 students (aged 14-15), has a relatively small sample size compared with Youth 2000, and is of limited utility for describing long term trends since it covers only the most recent years of the study period.

Aim and approach

This chapter provides a compilation of existing data, most of which is available in the public domain (apart from the ASSAD data from Australia). To my knowledge, this data has not yet been brought together to describe in detail, using robust national-level trend data, the international phenomenon of declining adolescent risk behaviour. The aim is to map the parameters of this megatrend, and observe patterns to identify clues as to the drivers of the decline.

I have used descriptive and graphical approaches to illustrate and compare broad trends between countries over time. It is important to note that because of differences in question wording, answer categories and age ranges for each survey, direct comparison of prevalence between countries may not be valid. However the aim is not to determine which country has the highest or lowest prevalence of each risk behaviour at a point in time, but to see whether trends over time are similar or different internationally.

My analysis relies heavily on self-report data, which has inherent limitations. For example, social desirability bias may lead young people to exaggerate risk behaviours in order to present themselves as ‘cool’ or ‘grown up’, or conversely to conceal risk behaviours for fear of getting into trouble if found out. Under- and over-reporting is likely to differ in demographic groups, reflecting gender norms, for example, and greater fear of sanctions for ‘misbehaviour’ among ethnic minorities due to systemic racism (Brener et al. 2003). Furthermore if social

desirability bias changes in degree or direction over time, that could result in inaccurate description of trends.

The question of whether adolescents' self-reports can be trusted has been well researched, and for behaviours that can be validated using biomarkers (e.g. tobacco and cannabis use) it appears there is generally a strong correspondence between self-report and objective measures (Brener et al. 2003). For sexual behaviour, biomarker testing is not possible. Other (more limited) methods of validity testing suggest we can have reasonable confidence in adolescents' self-reports of sexual behaviour, though the evidence is more mixed for sexual behaviour than substance use (Brener et al. 2003). Pregnancy rates and STI rates are determined by a range of factors, but can give some objective indication of trends in unprotected sex. All of the key data sources outlined above use self-administered questionnaires, and research has consistently found that this mode yields higher reported rates of adolescent risk behaviour than face to face interviews (Brener et al. 2003). Although data quality and comparability are imperfect (particularly for sexual behaviour indicators), I consider they are sufficient to meet the aims of this chapter.

With a few exceptions (outlined below), the data on which the following charts are based is taken directly from publications or web-based data tables, without any secondary analysis or manipulation on my part. Sources are provided below each chart, along with the measure and the age range of survey respondents. Note that due to inconsistencies between data sources, it was not always possible to use exactly comparable measures. For example English surveys divide tobacco use into '*weekly or more often'* and '*occasional'* (i.e. less than weekly), whereas the other countries of interest use *at least monthly* and *daily,* as primary indicators.

For lifetime use of substances, some data sources report 'ever' use and others report 'never' use. For consistency I have used 'ever' throughout, based on the inverse of 'never' where that was the only indicator reported. Where data were reported only for boys and girls separately (e.g. NZ smoking prior to 1999) I derived an approximate overall prevalence by averaging the gender-specific prevalences. Where New Zealand trends in adolescent risk behaviours had not previously been reported by age group, I calculated prevalence for secondary school students aged 15 or younger, based on the Youth 2000 data sets. Where survey periods fell across years, for example in both Australia and New Zealand's national health surveys, I aligned the data point with the latter year, e.g. 2011/12 survey results are presented as 2012.

Choice of indicators

The aim of the chapter is to illustrate and compare trends between different countries and different behaviours of public health importance. The choice of indicators was based both on public health relevance (as discussed in Chapter 2), and the pragmatic need to use indicators that were common to all or most of the countries of interest.

With regard to smoking, for example, long-term harm is associated with habitual smoking over many years, and uptake usually occurs as a staged process (Centers for Disease Control 2012). The primary indicators I have reported on are 'ever' smoking, 'regular' (weekly or monthly) smoking, and 'daily' smoking, reflecting the typical stages of progression. Note that alternative tobacco products (e.g. chewing tobacco) are commonly used by teenagers in the USA and parts of Scandinavia, and e-cigarettes have also become widely available in the countries of interest in recent years. However, combustible cigarettes are a greater and more universal concern from a public health perspective, and therefore other forms of tobacco use are not covered in this chapter.

Alcohol is the most widely used drug among adolescents, and both frequency and quantity of alcohol consumption are important from a public health perspective. The primary indicators presented are prevalence of lifetime/past year use; prevalence of regular (weekly/monthly) use; and prevalence of binge drinking, (generally defined as 5+ drinks in a single drinking occasion). Binge drinking puts young people at risk of acute alcohol harms such as injuries, violence, vehicle crashes and alcohol poisoning, which are the most immediate public health concerns associated with adolescent drinking, and also tend to be the focus of media attention. Long-term alcohol-related harms, including alcohol dependency, are also of public health concern and, as discussed in Chapter 2, early onset of drinking (particularly binge drinking) is a predictor of long-term harm. There is growing concern about the impact of alcohol on the developing brain (Squeglia & Gray 2016), and wide agreement that alcohol should be avoided completely before age 16. Therefore even moderate or occasional use in those aged under 16 is of public health interest.

Illicit drug use is relatively uncommon in adolescents aged less than 16, with the exception of cannabis, and therefore cannabis is the main focus of this section. As discussed in Chapter 2, cannabis use is associated with both acute risks e.g. injury and drug-induced psychosis, and long-term risks of heavy use e.g. addiction, altered brain development, cognitive impairment, and psychotic disorders (Volkow et al. 2014). Although dosage is important from a public health perspective (particularly for drugs other than cannabis; overdose is not considered a

risk for cannabis) data on dosage is not routinely collected in the countries of interest. The indicators presented are limited to prevalence of lifetime/past year use, and prevalence of regular (weekly or monthly) use.

The availability and quality of self-report trend data on sexual behaviour in adolescents is somewhat limited. However indicators such as age at first intercourse, prevalence of sexual experience (i.e. ever having sexual intercourse) before age 16, contraceptive use and condom use at most recent intercourse provide a broad picture of trends. As discussed in the previous chapter, although adolescent sex is not 'risky' per se, early sexual activity (before age 16) is more likely to be unprotected, and younger adolescents are at greater risk of coercive or unwanted sex. Furthermore, US evidence suggests that the delay between first sex and first contraceptive use is longer for those who start having sex at younger ages (Finer & Philbin 2013), and early age of sexual debut is associated with subsequent sexual risk behaviour and greater likelihood of teenage pregnancy (Heywood et al. 2015). For these reasons 'ever having sex' is of public health importance in the younger (<16) age group. From a public health perspective, protection from both unwanted pregnancy and sexually transmitted infections is important, so I have included both condom use and use of any contraception at most recent intercourse as key indicators. Statistics on teenage births are readily available in all the countries of interest and provide an objective (albeit indirect) indicator of frequency of unprotected sex among 15-19 year olds.

Teen abortion rates are also available in most countries (Australia is an exception) allowing teen conception rates to be calculated. It is important to note, though, that teen conception rates are a function of a number of factors: frequency and timing of sexual intercourse, use and effectiveness of contraception, and fecundity of both sexual partners. Conception rates cannot tell us the relative importance of these underlying factors as contributors to changes seen over time. It is also important to note that most births to teenage mothers are to young adults aged 18 or 19 years, rather than adolescents. Where available, I have included conception, birth and abortion statistics for younger age groups.

Tobacco smoking

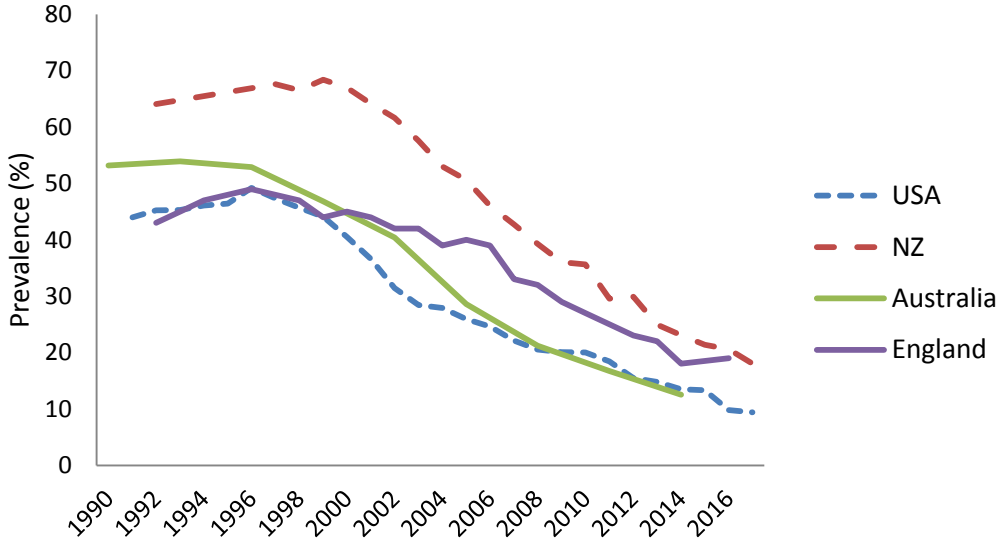
Trends in adolescent smoking

Lifetime use

The uptake of smoking is generally a gradual process, beginning with experimental smoking. In the 1990s such experimentation was the norm with half to two-thirds of early- to mid-

adolescents in all four countries reporting they had tried smoking at least once, as shown in Figure 3.

Figure 3: Ever tried smoking, adolescents, 1990-2017



Sources

USA: MTF grade 8, 13-14 years, lifetime prevalence

NZ: ASH year 10,(14-15 years ever smoked

Australia: ASSAD, 12-15 years, ever smoked

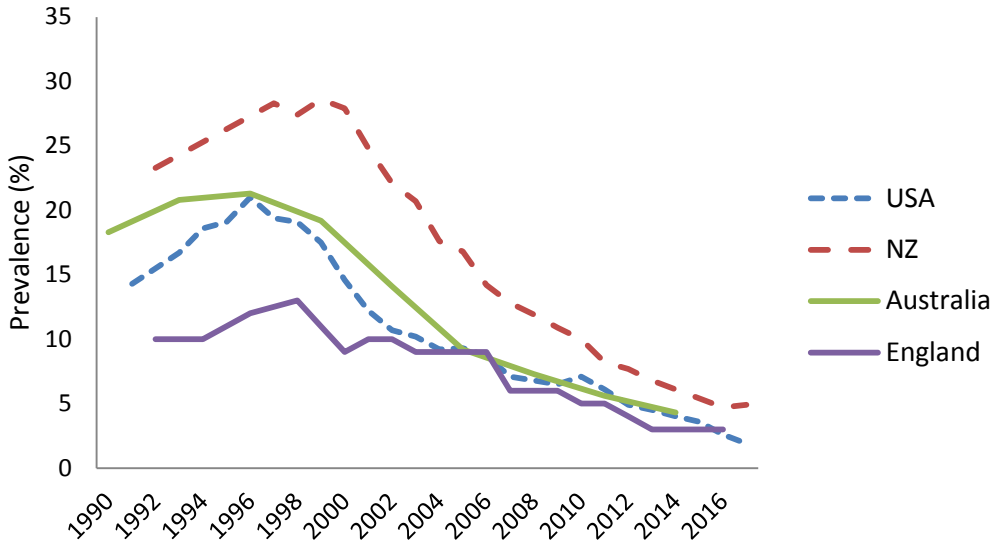
England: SDD survey,11-15 years, ever smoked

However, by 2014-2017 less than 20% in New Zealand and England had tried smoking by the age of 15, with prevalence of 'ever smoking' as low as one-in-eight in Australia (2014) and one-in-ten in the USA (2017). The data suggests that experimentation with cigarettes shifted from a mainstream to a minority activity over the study period.

Regular smoking

Regular (weekly or monthly) smoking among adolescents rose in the 1990s, particularly in the USA and New Zealand (Figure 4). More than a quarter of New Zealand adolescents smoked at least monthly in the late 1990s.

Figure 4: Regular smoking prevalence, adolescents, 1990-2017



Sources

USA: MTF grade 8, 13-14 yeas, 30 day prevalence

NZ: ASH year 10, 14-15 years, at least once a month

Australia: ASSAD, 12-15 year, past month

England: SDD survey, 11-15 years, at least weekly

As shown in Figure 4, regular smoking declined rapidly from the late 1990s in all four countries, with prevalence at or under 10% by 2010. The most recent data point in each country shows regular smoking at less than 5% in 2014-2017.

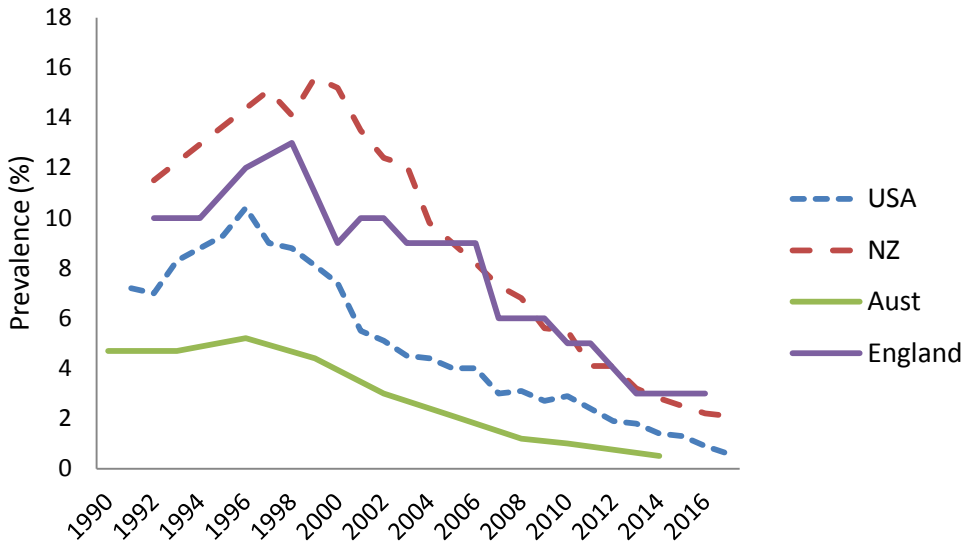
The pattern appears to be less dramatic in England, but it should be noted that regular smoking is defined as 'at least weekly' in England (whereas 'at least monthly' is used in the other three countries). In this age group we would expect weekly smoking to be less common than past month use.

It is also interesting to note that weekly smoking appears to have plateaued in England at 3%, with no further decline since 2013. New Zealand too may have hit a plateau; 2016 to 2017 is the first interval without a decline in regular smoking since 1999. In contrast, past month smoking has continued to decline in the USA to an all-time low of 1.9% in 2017.

Daily/weekly smoking

For many adolescents, experimentation with tobacco is a short-lived phase, but for a significant proportion the experimentation progresses to daily use. The prevalence of daily/weekly smoking in early- to mid-adolescence has seen the most marked change over the study period with steep rises during the 1990s in USA, New Zealand and England followed by precipitous falls (Fig 5). Trends were less dramatic in Australia, where daily smoking was already uncommon in 1990. However the same general pattern can be seen, with a peak in 1996 followed by steady declines. Note that in England teen smoking is divided into 'regular' (at least weekly) and 'occasional' (less than weekly), and data on daily smoking is not available. Figure 5 shows weekly smoking for England and daily smoking for the remaining countries.

Figure 5: Daily/weekly smoking prevalence, adolescents, 1990-2017



Sources

USA: MTF grade 8, 13-14 years, daily smoking

NZ: ASH year 10, 14-15 years, daily smoking

Australia: ASSAD, 12-15 years, daily smoking in past 7 days

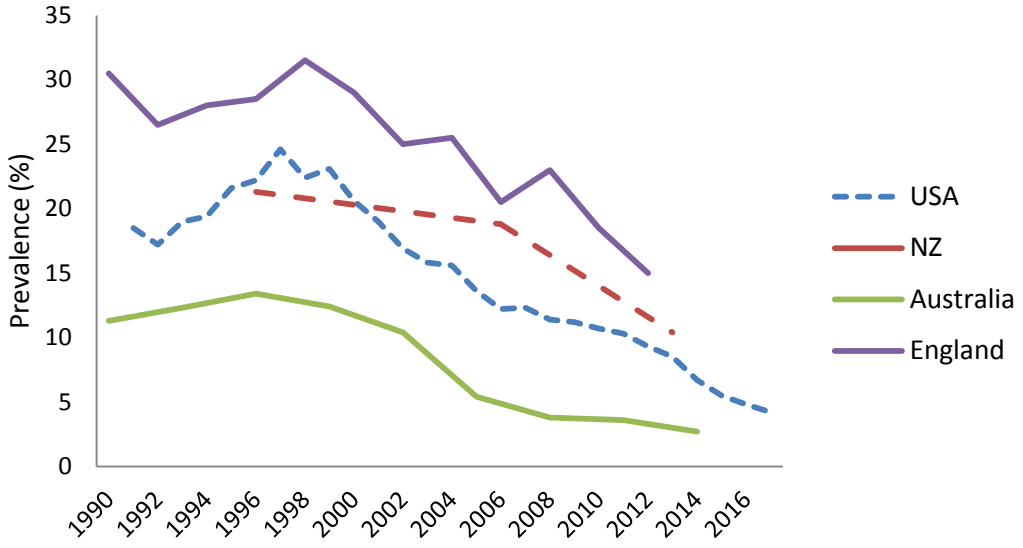
England: SDD, 11-15 years, at least weekly smoking

When adolescent smoking peaked in the late 1990s, a substantial minority in each country had an established smoking habit by early- to mid-adolescence. Daily smoking peaked in the USA and Australia first (1996), with daily smoking in this age group at 10% and 5%

respectively, followed by peaks in England in 1998 (with weekly smoking at 13%) and New Zealand in 1999 when 16% were daily smokers. Over the study period, prevalence has declined to 3% or less in all four countries, with daily smoking almost eliminated in the USA (0.6%, 2017) and Australia (0.5%, 2014), while England and New Zealand appear to have plateaued at about 3% and 2% respectively.

Daily/weekly smoking has also declined in older adolescents since the turn of the 21st century, as illustrated in Figure 6, which is based on general population surveys (NZ and England) and school-based surveys (Australia and USA). At its peak in the mid- to late-1990s, smoking in older teens was common, ranging from 13% of Australian 16-17 year old students reporting daily smoking (1996) to over 30% of English 16-19 year olds (1998) reporting smoking weekly or more often. Figure 6 shows that daily/weekly smoking prevalence in older teens in New Zealand and England halved between 1996/98 and 2012/13, while daily smoking prevalence of US 12th graders fell from a high of 25% in 1997 to 4% in 2017. Australia has the lowest rate of daily smoking in late-adolescence, at less than 3% (2014).

Figure 6: Daily/weekly smoking prevalence, older adolescents, 1990-2017



Sources

USA: MTF grade 12, 17-18 years, school-based sample daily smoking

NZ: Census, 15-19 years, general population, daily smoking

Australia: ASSAD, 16-17 years, school-based sample daily smoking in past 7 days

England: Opinions and Lifestyle Survey, 16-19 years, general population at least weekly

Published New Zealand data on smoking in older adolescents in the early 1990s is limited, making trends in this age group difficult to discern over the full study period. But it seems likely that smoking rose during the 1990s in this group, in line with younger adolescents in New Zealand and older adolescents in the other countries.

Distribution of trends

Adolescent smoking is strongly patterned by ethnicity and socio-economic status in the countries of interest, with smoking prevalence generally higher in socio-economically disadvantaged, ethnic minority and Indigenous populations (Ball et al. 2018b, Johnston et al. 2018). Such patterning is common to most high-income countries (de Looze et al. 2013). An exception is the USA, where African American adolescents have markedly lower smoking prevalence than their White counterparts (Oredein & Foulds 2011). Gender differences in the countries of interest are small.

In the USA, the rise in smoking prevalence in the early 1990s appears to have occurred across demographic groups but was particularly marked in high SES groups. This is explained by Gruber and Zinman in their 2001 report:

> *[S]moking participation is not simply concentrated among the most disadvantaged youths; indeed, increasingly over time, youth smoking is taking place among white, suburban youths with college-educated parents and good grades (Gruber & Zinman 2001, p 70).*

When adolescent smoking began to decline in the late 1990s, its prevalence fell almost simultaneously across demographic groups in England, New Zealand[5] and USA. For the first few years the decline was steeper in high SES groups, and, as a result, socio-economic disparities in adolescent smoking widened in absolute terms for the initial years of smoking decline. However, since the early/mid 2000s, smoking decline has been steeper in low SES groups, and absolute differences by SES are now narrower than they were when adolescent smoking was at its peak (Green et al. 2016, Ball et al. 2018b, Johnston et al. 2018).

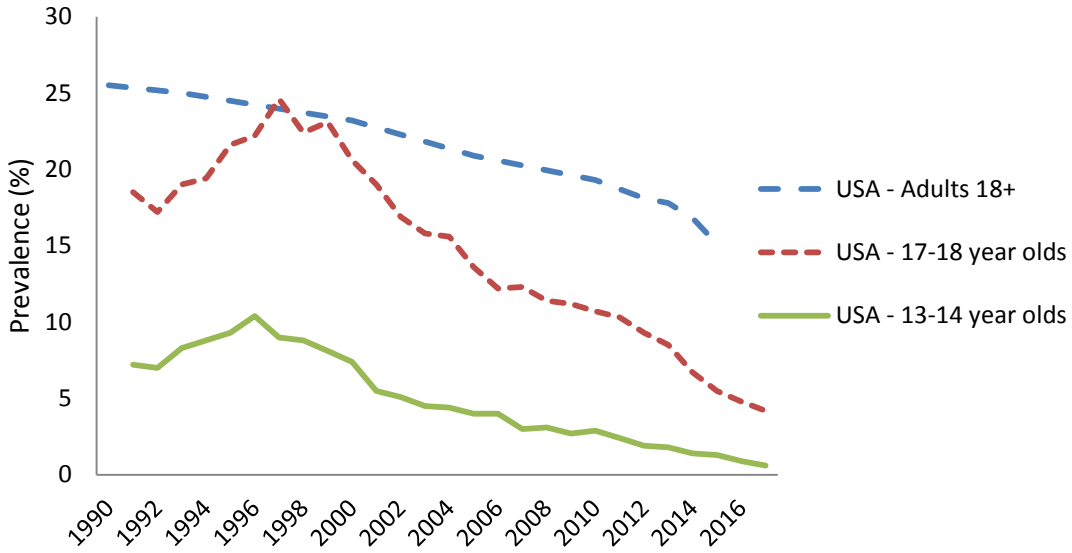
Comparison with adult trends

Smoking in Western adults peaked in the 1950s-1960s and has been gradually declining in all four countries of interest throughout the study period. The astonishing decline in teen

[5] Detailed analysis of smoking decline in New Zealand by SES and other demographic variables is provided in Chapter 5.

smoking since the late 1990s is considerably steeper than that seen in adults over the same period. Furthermore the rise in smoking prevalence in the 1990s was particular to adolescents. Differences between adult and adolescent smoking trends in the USA are illustrated in Figure 7, which shows trends in adult smoking, based on the National Health Interview Survey, alongside trends for older and younger secondary school students.

Figure 7: Current/daily smoking, adults and adolescents, USA, 1991-2017



Sources

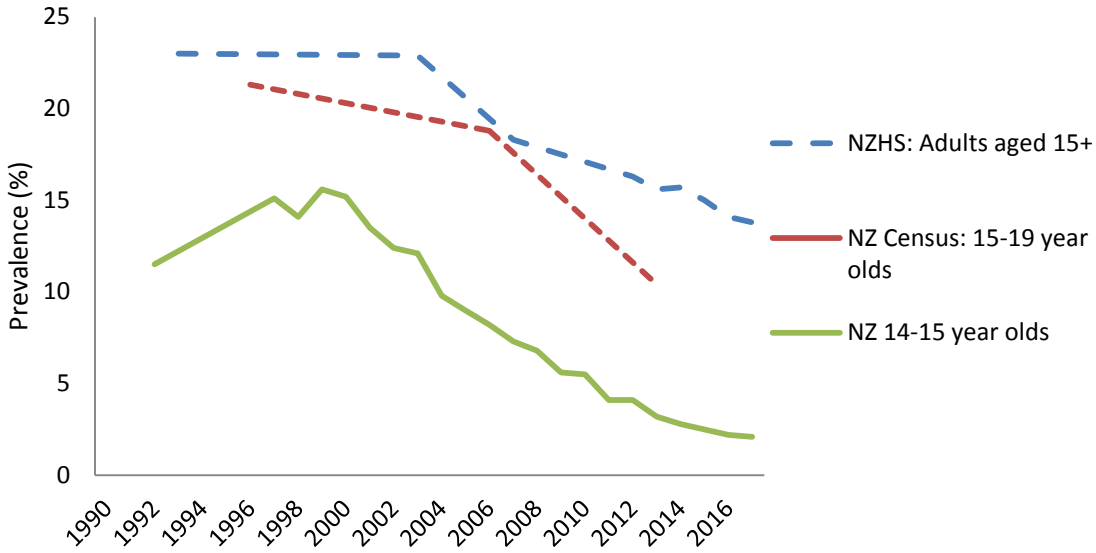
USA Adults (18+): National Health Interview Survey, current smokers

USA 17-18 years: MTF, 12th grade, daily smokers, school-based sample

USA 13-14 years: MTF, 8th grade, daily smokers school-based sample

The New Zealand comparison between adult, older adolescent and younger adolescent smoking trends in is provided in Figure 8. Again this shows a rise in adolescent (but not adult) smoking in the 1990s, followed by a steeper decline in adolescent than adult smoking, at least between 2000 and 2012.

Figure 8: Current/daily smoking, adults and adolescents, NZ, 1990-2017



Sources

NZ Health Survey 2002/03-2016/17, preceded by the Household Health Survey 1992/93, adults aged 15+, current smokers.

NZ Census: 15-19 years, daily smokers. (Tobacco Control Data repository, HPA)

NZ ASH year 10 Snapshot Survey, 14-15 years, daily smokers

The pattern appears to be similar in the other countries of interest, though (as previously noted) the rise in adolescent smoking in Australia during the 1990s was less marked than in other countries.

Comparison with other countries

A dramatic decline in adolescent smoking from the late 1990s to very low levels is not unique to the four countries of interest. Similar patterns can be seen in other high-income countries including Japan (Kanda et al. 2013), Canada (Reid et al. 2015), Iceland (Kristjansson et al. 2016), Scotland (Johnston 2016) and Norway (The ESPAD Group 2016) for example. Regular smoking prevalence was 10% or lower among early- to mid-adolescents in the most recent survey in all of these countries.

Strong declines in adolescent smoking have also been observed in many other European countries since 2000 including Austria, Belgium, Denmark, Finland, Germany, Ireland, the Netherlands, Portugal and Sweden. In many of these countries baseline smoking prevalence

was very high among adolescents, and remains relatively high despite recent declines. For example the ESPAD study shows that in 2015, 30-day prevalence in 15-16 year olds was 28% in Austria, 19% in Denmark and 22% in Finland (The ESPAD Group 2016).

Italy and France stand out as countries that defy the general pattern of strong declines in adolescent smoking since 2000. According to ESPAD findings, adolescent smoking has declined only modestly in France where 30-day prevalence among 15-16 year olds remained at 26% in 2015. In Italy, 37% of 15-16 year olds smoked in the past month, and there has been no significant change since the ESPAD study began in 1995 (The ESPAD Group 2016).

In high-income countries smoking rates are consistently higher in 'vocational track' adolescents and those living in low SES neighbourhoods, but *declines* in smoking over time do not appear to be consistently patterned by SES or educational level. For example, absolute differences in daily smoking by education level (i.e. academic versus vocational) decreased in Germany and the Netherlands between 2002 and 2010, but fluctuated or increased in several other European countries including France, Belgium and Italy (de Looze et al. 2013).

Between 1999 and 2008 the Global Youth Tobacco Survey recorded declines in 29 out of 100 countries included in the study, including Jordan, Georgia, Panama, Costa Rica and China (Warren et al. 2009). This suggests that declining adolescent smoking is not restricted to high-income countries, but is far from a global phenomenon.

Summary

In summary, trends in adolescent smoking since 1990 are remarkably similar in New Zealand, Australia, England and the USA. These trends are inconsistent with adult trends, and are characterised by a sudden rise in teen smoking in the early- to mid-1990s, followed by rapid declines across both genders and all ethnic and socio-economic groups. Smoking has become an uncommon activity among adolescents, rather than part of normal teenage experimentation, as was the case in the 1990s. Rapidly declining adolescent smoking is common to many (but not all) high-income countries, with Anglophone countries and parts of Scandinavia now having the lowest rates of teen smoking. Trends in middle- and low-income countries are mixed.

Alcohol use

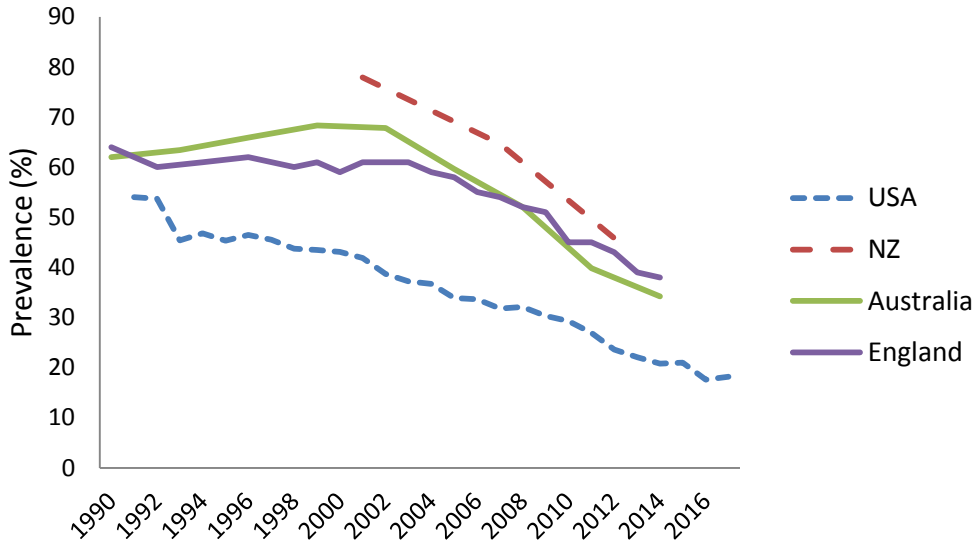
Trends in adolescent drinking

Lifetime/past year use of alcohol

Alcohol is the most commonly used substance among adolescents in Western countries. As shown in Figure 9, there was no clear international trend in drinking prevalence during the 1990s. Past year alcohol use declined in the USA, while increasing slightly in Australia and lifetime use in England remained steady. 1990s data from New Zealand is unavailable.

From the early 2000s, however, past year/lifetime use fell dramatically in all four countries, indicating that an increasing proportion of adolescents were abstaining from alcohol use completely. For example, the proportion of adolescents in this age group who drank in the past year halved from a peak of 68% (1999-2002) to a low of 34% (2014) in Australia, and more than halved in the USA from 54% in 1991 to 18% in 2016.

Figure 9: Lifetime/past year alcohol use, adolescents, 1990-2017



Sources

USA: MTF, 8th grade, 13-14 years, past year

NZ: Youth 2000, 13-15 years, lifetime

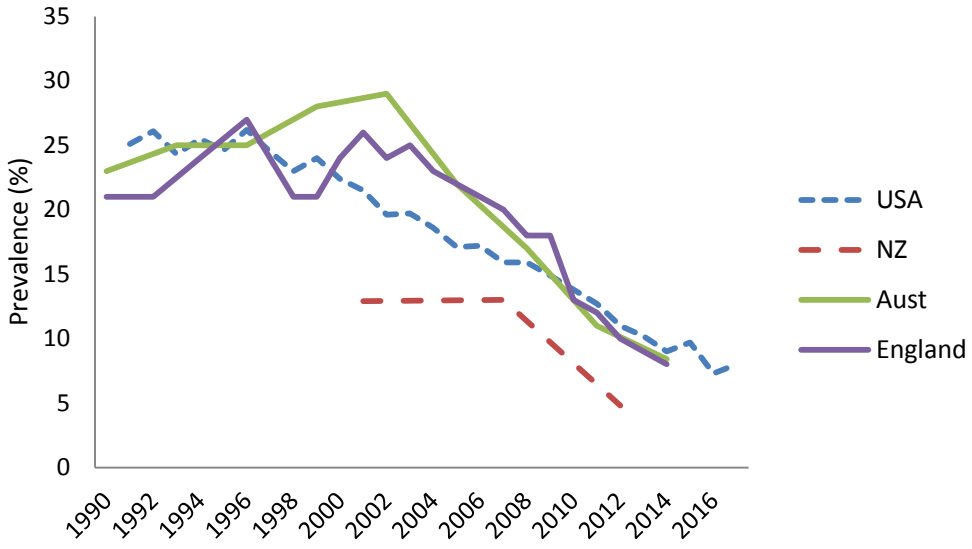
Australia: ASAAD, 12-15 years, past year

England: SDD, 11-15 years, lifetime

Regular alcohol use

Prevalence of weekly (Australia, NZ & England) or monthly (USA) alcohol use among adolescents has also declined dramatically since the early-mid-2000s, approximately halving between the high point and the most recent figure for each country (Fig 10).

Figure 10: Prevalence of regular alcohol use, adolescents, 1990-2017



Sources

USA: MTF, grade 8, 13-14 years, 30 day prevalence

NZ: Youth 2000, age 13-15 years, 'at least once a week'

Australia: ASSAD, 12-15 years, 'past 7 days'

England: SDD, 11-15 years, last drinking occasion was in the past week

In the USA the decline in prevalence of regular alcohol use in adolescents began in the late 1990s, about the same time tobacco use began to decline. In the other three countries, the decline in prevalence of regular alcohol use began several years *after* the decline in smoking. There are only three data points available for New Zealand (based on the Youth 2000 series), but it appears the decline in prevalence of weekly alcohol use did not occur in this country until after 2007, later than the other countries of interest. Note that the denominator is all students (not only drinkers), therefore the decline in regular drinking is at least partially driven by the increase in non-drinking. Data tables presenting regular drinking among past year/lifetime drinkers are not available in the public domain.

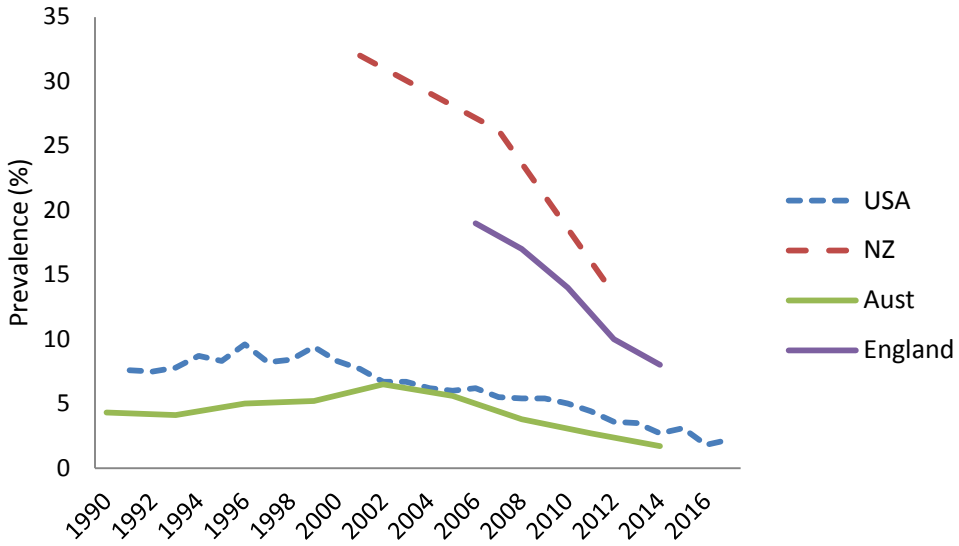
Frequency of alcohol use

A New Zealand study of drinking trends, 1995-2004, found that annual frequency of alcohol use increased dramatically in adolescents between 1995 and 2000, e.g. from 12.5 to 26.3 occasions per year for 14-15 year old boys, and from 14.3 to 25.8 occasions per year for girls of the same age (Huckle et al. 2011). Between 2007 and 2012 this trend reversed, with declines in drinking frequency among secondary school students in both genders and all socio-economic groups (Jackson et al. 2017). US trend analysis of 12-20 year olds based on the National Survey on Drug Use and Health (NSDUH) also shows that frequency of drinking rose in the 1990s in males and females, and fell in the 2000s among males while remaining steady among females, leading to a convergence of drinking frequency between sexes (Chen et al. 2015). I have not been able to identify studies on adolescent drinking frequency trends in Australia or England.

Prevalence of binge drinking

The proportion of adolescents engaging in binge drinking (defined as 5+ drinks in a single drinking occasion in Australia and NZ or 'being drunk' in England and USA) appears to have been stable in the 1990s, at least in Australia and the USA – the countries for which 1990s data is available. All four countries have seen a sharp decline since the early to mid-2000s in the proportion in this age group who regularly binge drink, as shown in Figure 11. Absolute declines have been greatest in countries with high baseline prevalence of binge drinking in this age group: New Zealand and England. Note that comparability between countries is particularly poor for this indicator, given that the age group surveyed, the measure ('drunkenness' /5+ drinks), and the time period (past week/past month) differ between countries.

Figure 11: Prevalence of binge drinking, adolescents, 1990-2017



Sources

USA: MTF, 8th grade, 13-14 years, 'been drunk' in past 30 days

Australia: ASAAD, 12-15 years, binge drinking (5+ drinks) in past 7 days

NZ: Youth 2000, 13-15 years, binge drinking (5+ drinks) in past 4 weeks

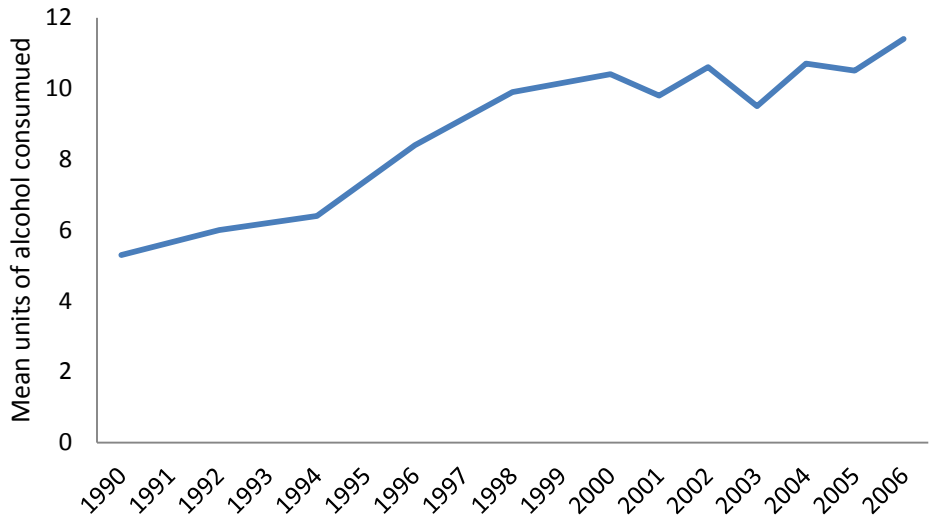
England: SDD, 11-15 years, 'been drunk' in last four weeks

Again, the denominator is all students (not only drinkers) so the decline in binge drinking is at least partially accounted for by the increase in non-drinkers. Analysis shows that, among ever drinkers, the proportion who reported they had 'been drunk' in the past four weeks declined significantly in England from 35% in 2006 to 21% in 2014, suggesting binge drinking is becoming less prevalent (or less frequent) among drinkers. However, in Australia and the USA, the decline in binge drinking among drinkers over the past 15 years has been more modest, suggesting that much of the decline in binge drinking in those countries is due to an increasing proportion of abstainers. In New Zealand the proportion of 13-15 year old 'ever drinkers' who had had a binge drinking occasion in the past month fell from about 40% in 2001 and 2007 to 30% in 2012. However, prevalence of past month binge drinking in past month drinkers has barely changed – two thirds of past month drinkers had had a binge drinking occasion in the past month in 2001, rising to 70% in 2007 and returning to 65% in 2012. This suggests that *frequency* of drinking has declined, but the *style* of drinking is largely unchanged.

Quantity of alcohol consumed

There is evidence from New Zealand, the USA and England that quantity of alcohol consumed by young people in a typical drinking session increased between the mid-1990s and early 2000s. For example, a New Zealand study found that increases in per-session quantity increased between 1995 and 2000 in most demographic groups, but particularly for older adolescents (16-18 years) and young adults (18-24 years). In the USA, the NSDUH survey of US 12-20 year olds shows that quantity consumed in a drinking session rose sharply in the second half of the 1990s in both genders and all main ethnic groups. It has fallen since 2000, but remains higher than 1991 levels (Chen et al. 2015). Data from England's SDD survey also suggests that, while the proportion of 11-15 year olds who had ever used alcohol was fairly stable between 1990 and 2004 at about 60%, the quantity consumed by those who drank in the past week approximately doubled over the same period (Fig 12). Due to methodological changes, figures before and after 2007 are not comparable, so only the data for 1990-2006 is presented. Past-week quantity decreased from 2007, but (lack of comparability notwithstanding) appears to have remained above early 90s levels.

Figure 12: Mean units of alcohol consumed in past week by 11-15 year old past week drinkers, England, 1990-2006



More recently, New Zealand research suggests that between 2007 and 2012 typical drinking-occasion quantity declined in secondary students overall, while increasing in certain adolescent subgroups, notably girls aged under 16 of low socio-economic status (Jackson et al. 2017).

These findings may help to explain why alcohol-related harm in adolescents (e.g. alcohol-related emergency department presentations) appears to have increased in several countries during a period when overall prevalence of adolescent alcohol use was declining (Livingston et al. 2010, Norstrom & Svensson 2014, Tyrrell et al. 2016, Green et al. 2017). Unpacking this data also reveals that population measures of alcohol use do not tell the whole story, and that trends in population subgroups may follow a different pattern from trends in adolescent drinking in the population as a whole.

Distribution of trends

Adolescent alcohol use is not as strongly patterned by deprivation as smoking, perhaps reflecting its social acceptability in the dominant culture. For example in New Zealand's secondary school population in 2012 the prevalence of binge drinking was similar in all deprivation groups and in both sexes at 21-23% (Adolescent Health Research Group 2013). However, in younger adolescents a social gradient is more apparent, suggesting that low SES adolescents begin binge drinking at a younger age than their high-SES counterparts.

In the USA, prevalence of adolescent alcohol use and binge drinking in 8th and 10th graders (aged 13-16 years) has declined in both sexes, all social strata and all ethnic groups, and absolute differences between demographic groups have generally narrowed since 2000 (Johnston et al. 2018). However, US data suggests declines in binge drinking have been greater in high SES compared with low SES adolescents (Pape et al. 2018).

Analysis of Australian non-drinking in 14-17 year olds shows that non-drinking increased significantly between 2001 and 2010 in both genders, rural and urban residents, and all ages (within the 14-17 year old range) and socio-economic quintiles. Non-drinking increased more in younger adolescents, those in low-income households, and those remaining at school (Livingston 2014). New Zealand research also found a greater increase in non-drinking among adolescents aged under 16, compared to adolescents aged 16-18 (Jackson et al. 2017).

Comparison with adult trends

Fluctuations in adolescent alcohol use occur against a background of changing usage in the population as a whole. In New Zealand, Australia and the USA per capita consumption peaked in the mid to late 1970s and fell during the 1980s, whereas in the UK the post-World War II rise in consumption continued into the 2000s, peaking around 2004. Binge drinking was historically the preserve of men in Anglo cultures, but in recent decades there has been a

convergence in the drinking behaviour of men and women, with the gender gap in hazardous drinking and alcohol-related harm closing in successive cohorts (Slade et al. 2016).

National per capita consumption of alcohol has fluctuated over the study period in the countries of interest, and does not conform to an international pattern of decline in the early 21st century as seen in adolescents. In countries where overall consumption has declined in recent years (e.g. Australia) there is evidence that this is driven by light drinkers becoming non-drinkers (Callinan et al. 2017) and by decreasing drinking prevalence and consumption in younger cohorts rather than reduced drinking across the population as a whole (Livingston et al. 2016).

Young adults are the age group with the highest prevalence of hazardous drinking, yet in all the countries of interest young adult drinking has declined over the past 10 years (Livingston & Vashishtha, in draft). In contrast to adolescents and young adults, the prevalence of hazardous drinking among middle-aged adults has increased over the study period, particularly in the past 10 years. For example, the New Zealand Health Survey shows that the proportion of past year drinkers classified as 'hazardous drinkers' significantly increased between 2006/07 and 2015/16 in age groups from 25 to 54 years, but significantly decreased in 15-24 year olds. In Great Britain, the proportion of past week drinkers who exceeded 8 units of alcohol on their heaviest drinking day increased between 2005 and 2016 in those aged 45+, but decreased in those under 45. Australian data shows a rise in heavy binge drinking (20+ drinks/session) in middle-aged Australians (Livingston et al. 2016). US studies also show a rise in adult binge drinking in recent years (Naimi et al. 2003, Han et al. 2017, Patrick et al. 2017, Grucza et al. 2018a). There is some evidence of a cohort effect whereby heavy-drinking adolescents of previous decades may be continuing heavy-drinking patterns into middle-age, whereas lighter-drinking adolescent cohorts of the past 10-15 years appear to be growing up to be lighter-drinking young adults (Livingston et al. 2016).

Although hazardous drinking has increased in the adult population, over the same period the proportion of non-drinkers in the adult population increased modestly. For example in New Zealand the proportion of non-drinkers has increased from 16% (2006/07) to 21% (2014/15) of the adult population (Ministry of Health, 2016). In Australia non-drinkers have increased from 9% (2001) to 14% (2013) of the adult population (Livingston, 2015). There was also a 2% (absolute) increase in adult non-drinkers in Great Britain between 2005 and 2016 (Office for National Statistics 2017).

Comparison with other countries

The trends seen in New Zealand, Australian, English and American adolescents since the early 2000s – increasing prevalence of alcohol abstinence, less frequent drinking, and declining population prevalence of binge drinking – are common to many (but not all) high-income Western countries.

Given cultural differences in the frequency of alcohol use and social acceptability of drunkenness, it is notable that weekly alcohol use in 11-15 year olds decreased significantly between 2002 and 2010 in almost all 28 European and North American countries in the HBSC study (de Looze et al. 2015b). This included countries from all geographical quadrants of Europe. In many of these countries the prevalence decreased by half or more – a remarkable change in an eight-year period. Exceptions included France, Austria, and the Czech Republic, where weekly alcohol use was stable over time, albeit at widely differing prevalence rates: 7%, 11%, and 20% respectively in 2010.

According to the ESPAD study, prevalence of binge drinking among 15-16 year olds declined markedly in many countries between 1995 and 2015, including Iceland (36% to 8%), Sweden (41% to 22%), Finland (51% to 23%), Norway (37% to 19%) and Ireland (47% to 28%) (Hibell et al. 1997, The ESPAD Group 2016). The ESPAD study also shows that prevalence of non-drinking among 15-16 year olds, which was rare in 1995, increased markedly since the turn of the century in many countries. By 2015 more than a quarter of 15-16 year olds in Iceland, Norway, Ireland, the Netherlands and Sweden reported they had never drunk alcohol (The ESPAD Group 2016). However declines in alcohol use and binge drinking were far from universal. For example binge drinking increased or remained at very high levels in the early 21st century in France, the Czech Republic, Austria, Denmark, and Italy (The ESPAD Group 2016).

Summary

There is evidence that frequency of adolescent alcohol use and per-session drinking quantity rose markedly in the 1990s in most of the countries of interest. Since the turn of the 21st century a sea change has occurred in adolescent drinking behaviour, with a divergence between adult and adolescent trends. Since the early- to mid-2000s an increasing proportion of adolescents in the countries of interest are non-drinkers, and those who do drink are drinking less frequently. This pattern is consistent across most (but not all) Anglo and European countries. Adolescent binge drinking has declined at the population level in all the

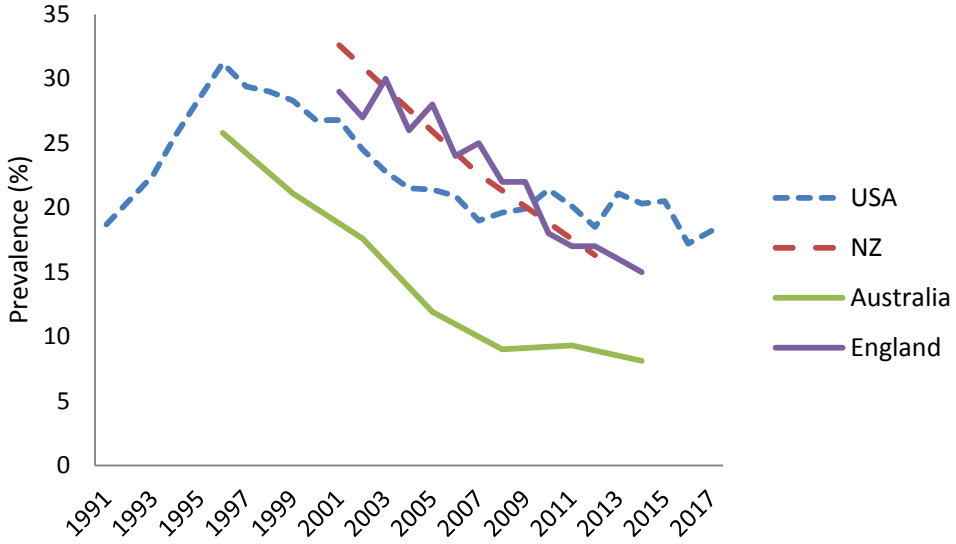
countries of interest, but the extent to which binge drinking has declined among drinkers is less consistent. It appears that the prevalence and frequency of adolescent alcohol use have changed more dramatically in most countries than the typical style of adolescent drinking. Declines in alcohol use and binge drinking have also been observed in young adults over the past decade in all the countries of interest, whereas hazardous drinking in middle-aged adults has increased.

Illicit drugs

Trends in adolescent illicit drug use

Data on illicit drug use in adolescents is less available than for tobacco and alcohol, and only the USA has data covering the entire study period. Figure 13 shows prevalence of lifetime use of any illicit drug in the USA, Australia and England and lifetime use of cannabis in New Zealand (since data on any illicit drug use was not available in the public domain). It illustrates a sharp rise in adolescent drug use in the early 1990s in the USA, followed by a steep decline until the mid-2000s. This steep decline was mirrored in Australia, New Zealand, and England. The decline plateaued from the mid-2000s in Australia and the USA, but has continued to the latest available data point in England (2014) and New Zealand (2012).

Figure 13: Lifetime use of any illicit drug, adolescents, 1991-2017



Sources

USA: MTF, 8th grade, 13-14 years, lifetime, any illicit drug

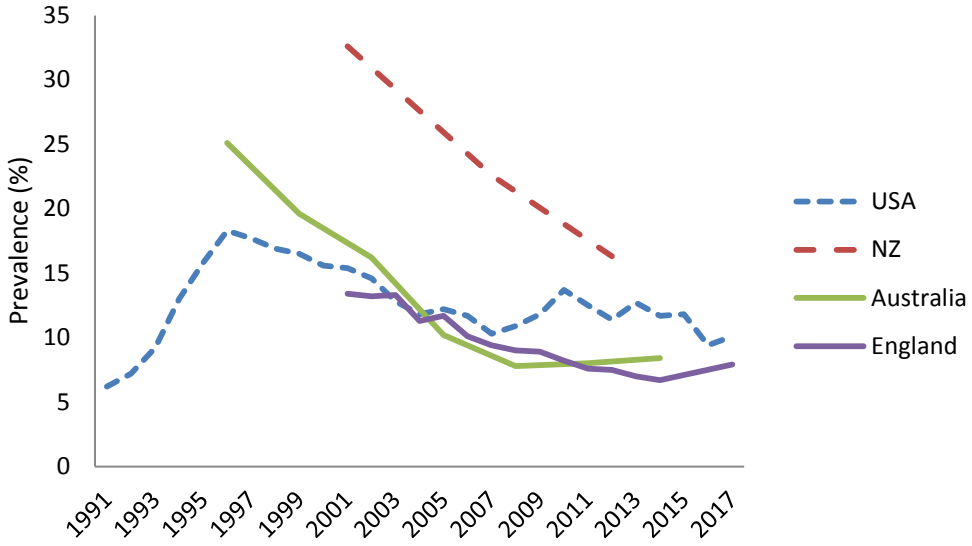
NZ: Youth 2000, 13-15 years, lifetime, cannabis

Australia: ASSAD, 12-15 year, lifetime, any illicit drug

England: SDD, 11-15 years, lifetime, any illicit drug

Cannabis is by far the most commonly used illicit drug among adolescents in all the countries of interest, and therefore trends in cannabis use are similar to trends for drug use overall (Fig 14).

Figure 14: Lifetime/past year cannabis use, adolescents, 1991-2017



Sources

USA: MTF, 10th grade, 15-16 years, past year prevalence

NZ: Youth 2000, 13-15 years, lifetime

Australia: ASSAD, 12-15 years, past year prevalence

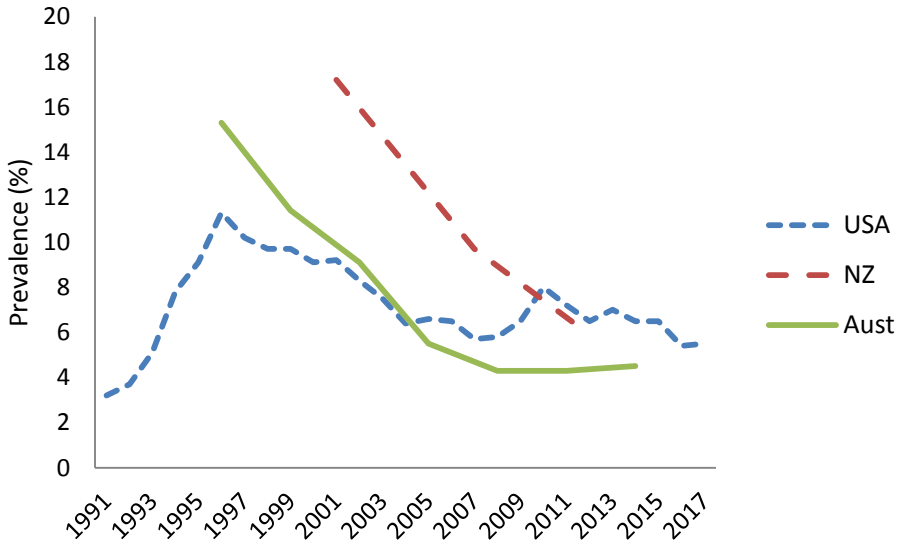
England: SDD, 11-15 years, past year prevalence

The timing of the 1990s rise and subsequent fall of cannabis use in the USA was similar to that of tobacco, but the fall in cannabis use was more gradual. Because data collection on cannabis use in Australia, New Zealand and England does not go back to the early 1990s, we do not know whether these countries also had a spike in cannabis use corresponding with the rise in tobacco use in the 1990s. In all four countries, cannabis use peaked in the late 1990s or early 2000s and declined subsequently. The decline halted in 2007/2008 in Australia and the USA,

and in 2014 in England, but in all four countries the latest recorded prevalence remains well below that at the turn of the 21st century.

Figure 15 shows the prevalence of past month cannabis use which fell from 15% in 1996 to 4% in 2008 in Australia, with a similarly rapid decline in New Zealand occurring between 2001 and 2012. Trends in past month use in the USA closely followed lifetime cannabis use trends (albeit at lower prevalence levels), rising sharply in the early- to mid-1990s, then declining until 2007, and fluctuating over the most recent decade of the study period. Trend data on regular cannabis use in English adolescents was not available.

Figure 15: Prevalence of past month cannabis use, adolescents, 1991-2017



Sources

USA: MTF, 10th grade, 15-16 years, 30 day prevalence

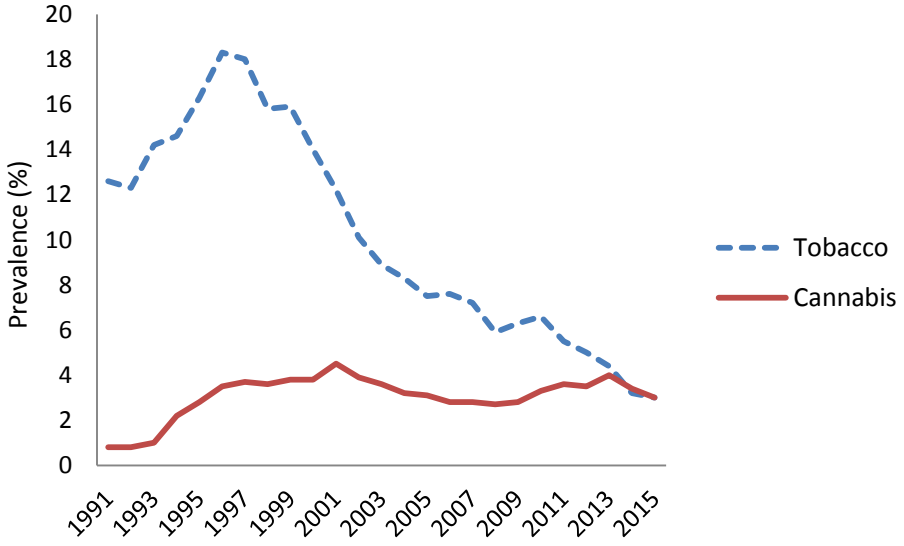
Australia: ASAAD , 12-15 year, past month use

NZ: Youth 2000, 13-15 year, past month use

Only the USA had available data on daily use of cannabis, which increased over the study period but remains uncommon. It is interesting to note that in the USA daily use of cannabis is now as prevalent as daily tobacco smoking among 10th graders (15-16 year olds) at approximately 3% (Fig 16). Among 12th graders (17-18 year olds) in the USA, prevalence of

daily cannabis use overtook daily tobacco use in 2015, and was 6% in 2017, compared to 4% for tobacco.

Figure 16: Prevalence of daily use, tobacco and cannabis, 15-16 year olds, USA, 1991-2015



Source: USA, MTF, 10th grade, 15-16 years

Distribution of trends

Internationally, use of cannabis – and illicit drugs in general – tends to be more prevalent in boys than girls. For example, in New Zealand in 2012, boys were more likely to be current cannabis users than girls (14.4% versus 11.5%) and were more than twice as likely to use cannabis weekly or more often (4.6% versus 2%) (Adolescent Health Research Group 2013). However, research from the USA suggests that, as with alcohol use, gender differences in cannabis use have narrowed over time among adolescents (Johnson et al. 2015). Patterning by ethnicity and SES is generally similar to that of tobacco use in the countries of interest, with cannabis use more prevalent in high-deprivation neighbourhoods, and in ethnic minority and Indigenous populations (Adolescent Health Research Group 2013, de Looze et al. 2015a, Johnson et al. 2015).

US data suggests that adolescent cannabis use declined between 1999 and 2013 in both sexes and in all main ethnic groups with the exception of Native Americans and Native Hawaiians (Johnson et al. 2015). My analysis of New Zealand's Youth 2000 data shows that between

2001 and 2012 declines in cannabis use occurred across all main demographic groups by age, sex, ethnicity and school decile (Ball et al, accepted for publication). Declines were particularly large for Māori, younger students, and those in low socio-economic neighbourhoods. Ethnic and socio-economic differences in adolescent cannabis use remain marked, but narrowed over the study period. I have not identified studies documenting Australian or English trends in adolescent cannabis use by sex, SES or ethnicity.

Comparison with adult trends

Patterns of use seen in adolescents (with males, ethnic minorities and low SES groups generally having higher rates of regular cannabis use) are also typical among adults in the countries of interest. However there is no evidence of a general international decline in cannabis use among adults in recent years, as seen in adolescents. In fact, US research shows past year and past month cannabis use has increased in the adult population (aged 18+) since 2005, with increases across all adult age bands (Hasin 2018, Kerr et al. 2018). In New Zealand the prevalence of past year cannabis use among adults increased from 8% in 2011/12 to 12% in 2016/17 (New Zealand Drug Foundation 2019). In contrast, daily and weekly cannabis use declined in Australian adults between 2001 and 2013, however this trend was largely confined to high SES groups (Chan et al. 2018). Data from England and Wales also points to a marked decline in past year cannabis use among adults since 2000, with the overall trend largely driven by strong declines in young adults aged 16-24 years (Home Office 2017).

Comparison with other countries

Although cannabis is consistently the illicit drug most commonly used by adolescents in high income countries, prevalence of use varies widely between countries. For example, in 2015 past-month cannabis use in 15-16 year olds ranged from 2% in Norway to 17% in France (The ESPAD Group 2016).

The ESPAD study found that, across Europe as a whole, the prevalence of current cannabis use in 15-16 year olds increased from 4% to 7% between 1995 and 2015, peaking in 2003 and decreasing slightly thereafter. This suggests a broadly similar pattern to that seen in the countries of interest, but with a lag of several years. Many high-income European nations (e.g. Switzerland, the Netherlands, Ireland, Belgium and Denmark) with formerly moderate or high rates of cannabis use have seen a marked drop in prevalence since 2003. In Italy, France and Austria, however, prevalence has fluctuated since 2003 and has not declined significantly from

peak levels. Other countries such as Norway and Sweden have historically had very low rates of use, and prevalence has remained low over the study period (The ESPAD Group 2016).

Summary

The downward trend in illicit drug use in adolescents is less consistent across high-income countries than for alcohol and tobacco use. However a general pattern of declining use can be observed in the countries of interest during the first decade of the 21st century. In the most recent few years, adolescent cannabis use has plateaued, fluctuated or risen slightly in the USA, Australia and England, but still remains well below peak levels of the late 90s/early 2000s. Cannabis use has also declined in some (but by no means all) other high-income Western countries. Among adults, prevalence of cannabis use has declined in some countries (Australia, England) but risen in others (New Zealand, USA).

Sexual behaviour

Trends in adolescent sexual behaviour

Sample sizes of the surveys used to monitor adolescent sexual behaviour are generally smaller than the substance use surveys used above and therefore prevalence estimates are likely to be less precise. It is also important to note that the 2014 iteration of the Australian National Survey of Secondary Students and Sexual Health is not nationally representative and may not be comparable with previous years. In combination with the low response rate for the 2008 iteration, this means Australian trends in particular must be treated with caution.

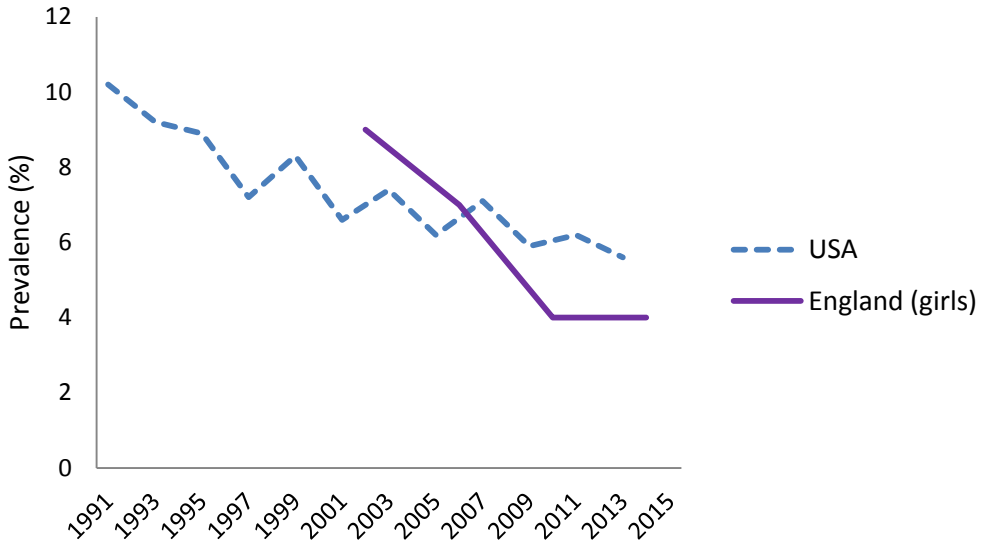
Age at first intercourse

Decreasing average age of first sexual intercourse has been observed in successive cohorts born between World War II and 1980 in Britain (Mercer et al. 2013) and the USA (Wells & Twenge 2005, Finer & Philbin 2013), which is likely to be indicative of trends in culturally similar countries such as Australia and New Zealand. However, recent research suggests there has been a reversal of this long-term trend, at least in the USA. The average age of first sexual intercourse *has increased* in cohorts born from about 1980 i.e. secondary school students from the early 1990s (Finer & Philbin 2013, Finer & Philbin 2014).

Very early sexual debut (at less than 13 years of age) has become increasingly uncommon in England and the USA, as shown in Figure 17. In the USA the proportion reporting first sex aged

less than 13 years of age almost halved over the study period, from 10.2% in 1991 to 5.6% in 2013, while in England there was a similar decrease from 9% to 4% over a shorter period. It is unclear to what extent these trends reflect consensual sexual activity; they may reflect a decline in sexual abuse (Finkelhor et al. 2014, Harris 2017).

Figure 17: Prevalence of early sexual debut (aged <13 years), 1991-2015



Sources

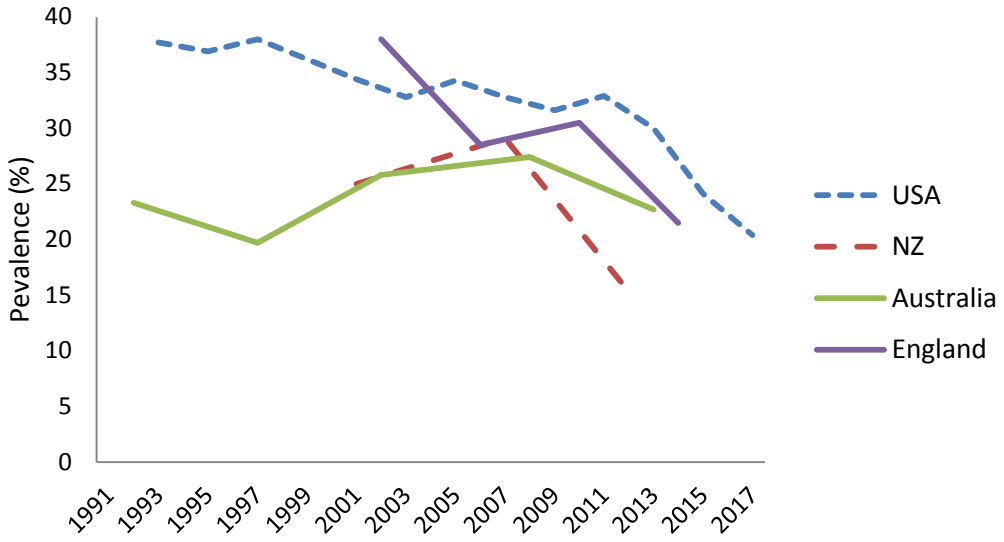
USA: YRBS, grades 9-12, 15-18 years

England: HBSC, 15 year

Prevalence of sexual experience

Corresponding with later sexual debut in recent cohorts (at least in the USA), there has been a marked decline since the early- to mid-2000s in the proportion of adolescents reporting experience of sexual intercourse (Fig 18). Australia is the exception to this trend, though, as noted above, Australian trend data must be treated with caution. Note that sexual abuse was explicitly excluded in the New Zealand question in 2012, but not in previous years, and this methodological change may account for some of the decline observed between 2007 and 2012 in New Zealand.

Figure 18: Proportion with experience of sexual intercourse, adolescents, 1991-2017



Sources

USA: YRBS, 9th grade, 14-15 years

NZ: Youth 2000, age 15 and under

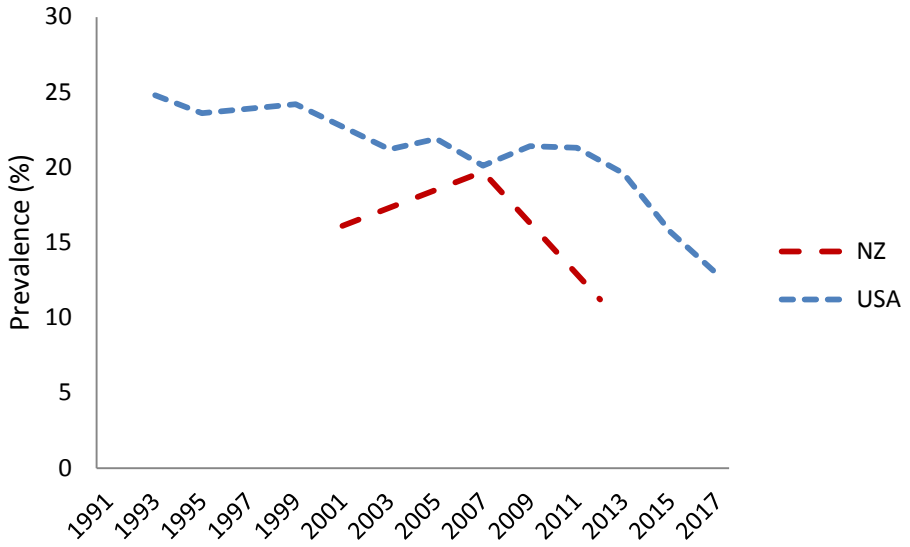
England: HBSC, 15 years

Australia: NSASSSH, year 10, 15-16 years

Currently sexually active

Over the study period the proportion of adolescents aged under 16 who were currently sexually active (i.e. had had sexual intercourse in the past 3 months) fell in New Zealand and the USA, the only countries to report this measure. As shown in Figure 19, about a quarter of US 9th graders (aged 14-15) were sexually active in the 1990s, falling to 13% in 2017. In New Zealand, the prevalence of sexual activity in 13-15 year olds rose between 2001 and 2007, but fell over the study period as a whole from 16% in 2001 to 11% in 2012 (Fig 19). This fall was only observed in younger adolescents; there was no marked decline in sexual activity in New Zealand students aged 16 and above over the study period (Clark et al. 2016).

Figure 19: Proportion sexually active, adolescents, 1991-2017



Sources:

USA: YRBS, 9th grade, 14-15 years

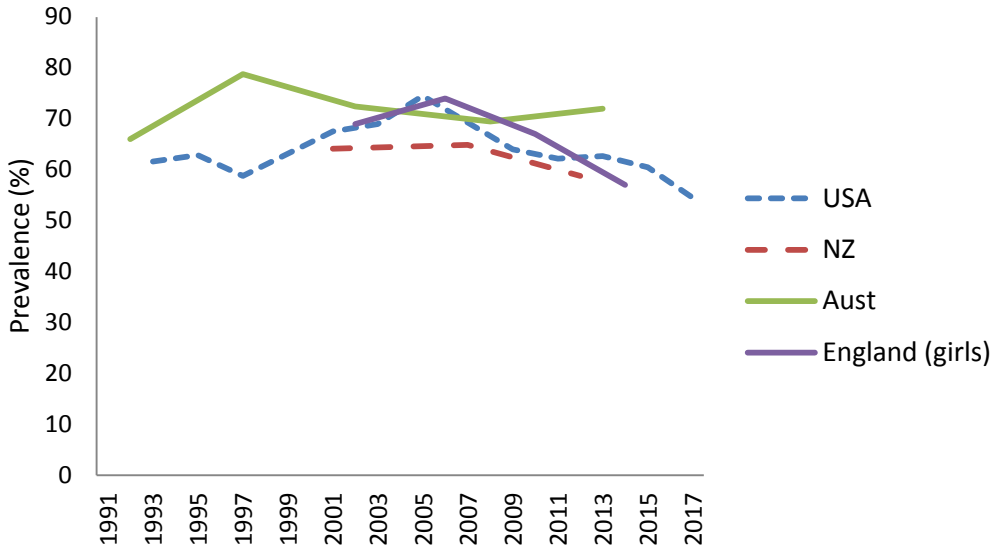
NZ: Youth 2000, secondary students aged 15 and under

In the USA the proportion of sexually active 9th to 12th graders who reported having four or more sexual partners in their lifetime almost halved from 19% in 1991 to 10% in 2017. This change may be at least partly attributable to delayed sexual debut in more recent cohorts. In contrast, Australian data show that, among students who had ever had sex, the proportion reporting more than three partners in the past year fluctuated between 16% (1997) and 30% (2008) with no clear pattern of decline.

Trends in adolescent contraception

Condoms are the most frequently used form of contraception for secondary school students in the countries of interest, particularly for those aged under 16, and are important for the prevention of sexually transmitted infections. Trends in condom use do not conform with a general decline in risk behaviour; although condom use increased in the 1990s in the USA and Australia (the only countries for which 1990s data was available) it has since declined in all countries of interest (Fig 20).

Figure 20: Condom use at most recent intercourse, sexually active adolescents, 1991-2017



Sources:

USA: YRBS, 9th grade, 14-15 years

England: HBSC, 15 year old girls

Australia: NASSSH, year 10, 15-16 years

NZ: Youth 2000, age 15 and under

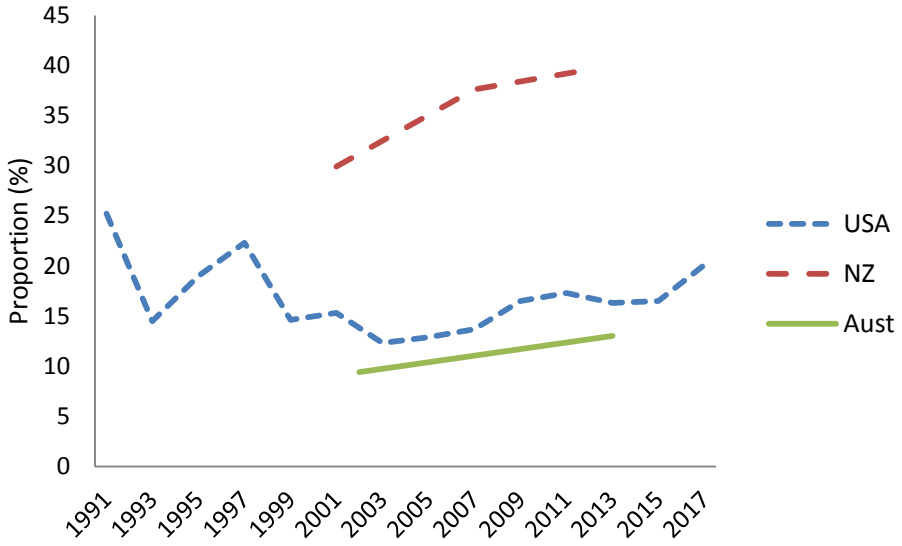
Declining condom use has coincided with increasing use of hormonal contraceptives among sexually active teenagers, at least in the USA (Kann et al. 2016, Lindberg et al. 2016) and UK (Rashed et al. 2015). Note that a large majority of participants in these studies were aged 16 years or over; trends specific to those aged under 16 years were not reported.

Whether contraceptive access for younger adolescents has improved or declined over the study period in the countries of interest is unknown. However in New Zealand the proportion of sexually active students reporting 'always' using contraception significantly declined between 2001 and 2012 in those aged under 16, but not in older students (Clark et al. 2016).

Although there is some evidence (at least from the USA and UK) that those using contraception are increasingly using 'highly effective' (i.e. hormonal) methods, the proportion of sexually active adolescents aged under 16 who report using *no* contraception at last intercourse has increased in the USA, New Zealand and Australia and since the turn of the century (Fig 21). In New Zealand the proportion is alarmingly high, with 40% of sexually active

students aged under 16 reporting they had not used contraception last time they had sex in 2012. Although the HBSC survey collects data on adolescent contraception, trend data for England is not available in the public domain.

Figure 21: No contraception used at most recent intercourse, sexually active adolescents, 1991-2017



Sources

USA: YRBS, 9th grade, 14-15 years

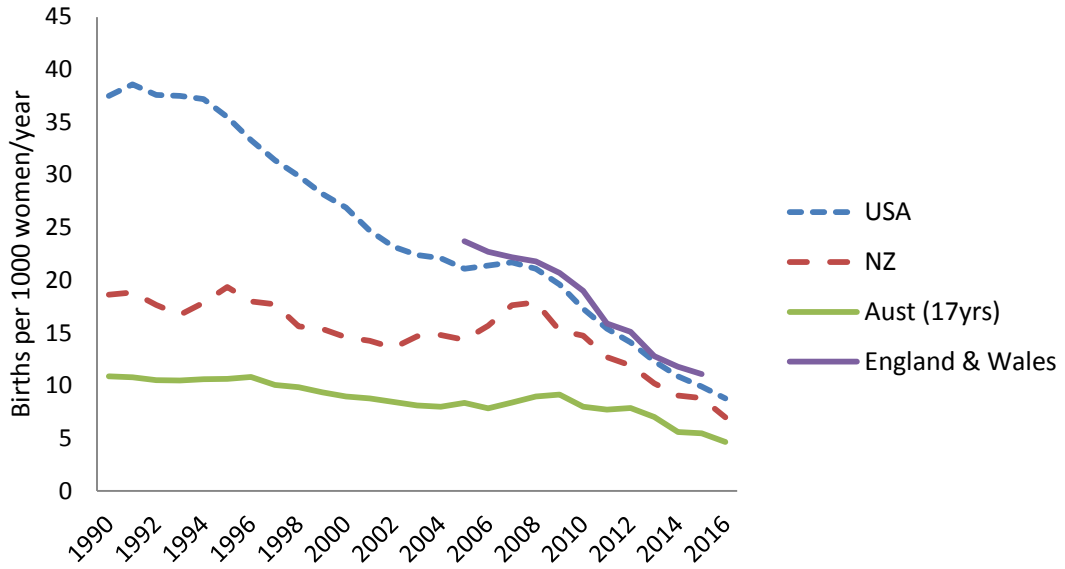
NZ: Youth 2000, aged 15 and under

Australia: NASSSH, year 10-12

Trends in teenage births and abortion

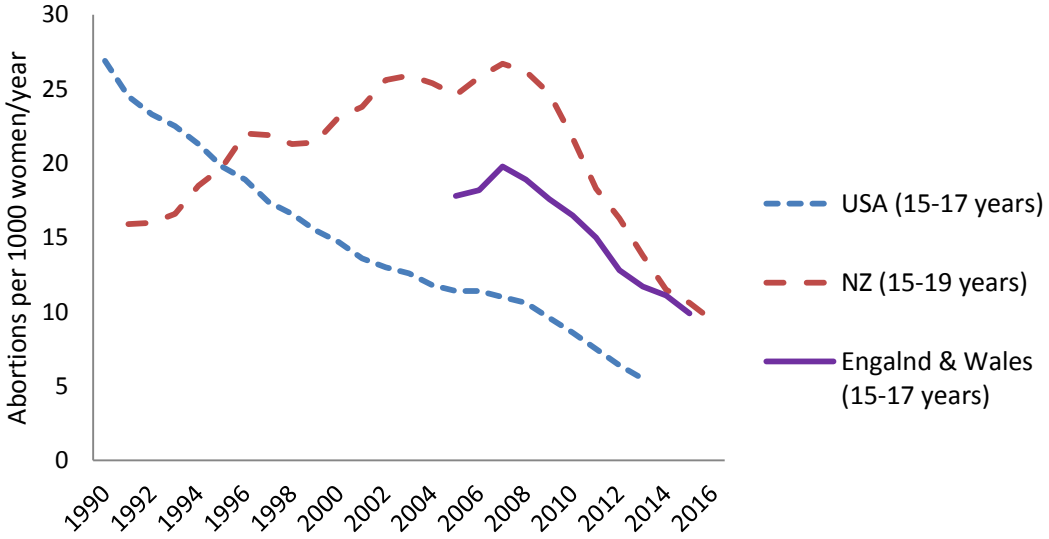
As shown in Figure 22, all four countries have seen a marked decline in the birth rate of young women aged 15-17 over the study period. Note that for Australia only age-specific rates are available, and so the rate for 17 year olds is presented. The rate for 15-17 year olds is likely to be substantially lower.

Figure 22: Birth rate per 1000 women aged 15-17 years, 1990-2016



The decline in teen births cannot be explained by a rise in teen abortions. In fact, teen abortions have declined even more sharply than teen births since 2008 in some countries (Fig 23).

Figure 23: Abortion rate per 1000 adolescent women, 1990-2016



As shown in Figure 23, abortions among 15-17 year old women in the USA declined steadily over the full study period. In contrast, New Zealand observed a rising abortion rate from 1990–2007 among 15-19 year olds, which subsequently fell from a high of 27 per 1000 women

in 2007 to 11 per 1000 in 2015. (Note there are no official statistics on abortion rates in Australia, and I have been unable to source data for England and Wales prior to 2005.)

Distribution of trends

Early sexual debut and births to adolescents are more prevalent in low SES, Indigenous and ethnic minority communities in all the countries of interest (Lewis & Skinner 2014, McCall et al. 2015, Pawar et al. 2015, Kost et al. 2017).

Ethnic differences have narrowed over the study period in New Zealand and the USA, with particularly pronounced declines in adolescent sexual activity and birth rates among New Zealand Māori and African American adolescents respectively (Santelli & Melnikas 2010, Pawar et al. 2015, Romero et al. 2016, Kost et al. 2017). In contrast, the birth rate for Aboriginal 15-19 year old women in Australia did not decline overall between 1998 and 2010, despite substantial declines in some states. As a result the gap between Indigenous and non-Indigenous teen birth rates has increased over the study period in Australia (Lewis & Skinner 2014).

In New Zealand secondary school students, the recent decline in condom use at most recent intercourse did not differ markedly by age, sex, or ethnicity (Clark et al. 2016).

Comparison with adult trends

Recent research suggests that people of all ages may be less sexually active than in previous time periods. Among adults, frequency of sexual intercourse decreased during the 2000s in Britain (Mercer et al. 2013) and the USA (Twenge et al. 2017), and research from the USA suggests that those born after 1990 are less likely to be sexually active in early adulthood than previous generations (Twenge et al. 2016).

In the US, historical trends in teen fertility have closely matched overall fertility rates, until the mid-90s when trends for teens and the general population diverged: teen pregnancy began to fall sharply while overall fertility slightly increased (Santelli & Melnikas 2010).

Comparison with other countries

Historically, there has been wide variation between countries in the 'typical' age of sexual debut, however the decline in the average age following World War II until the 1990s was common to most developed nations (Bozrm & Kontula 2014). While this trend appears to have reversed in England and the USA, only Scotland, Finland and Macedonia (out of 20 European

countries surveyed) had a significant decrease between 2002 and 2010 in the proportion of 15 year olds reporting ever having sex (Ramiro et al. 2015). This suggests that the pattern seen in England and the USA is not common to high-income countries in general.

Evidence from Scotland suggests that adolescent sexual activity decreased and use of condoms also decreased between 2002-2014 (Neville et al. 2017), indicating commonality between Scottish, English, US and New Zealand trends.

Teenage birth rates in most European countries have been low, historically, compared with Anglo countries. The decline in teen pregnancy over the study period appears to be an almost universal trend in high-income Western countries, with Denmark the only country with an increase in teen pregnancy between 1995 and 2011 (from a very low base), according to a recent review (Sedgh et al. 2015).

Summary

Evidence suggests that adolescents in the countries of interest (with the possible exception of Australia) are starting to have sex later and are less likely to be sexually active than previous cohorts. However, prevalence of condom use, the most commonly used contraceptive among adolescents, has declined since the turn of the 21st century, and the proportion of adolescents reporting using no contraception the last time they had sex has increased. Adolescent pregnancy has declined markedly over the study period, and increased use of hormonal contraception appears to have played a role, at least in England and the USA, along with lower rates of sexual activity.

Other adolescent health indicators

To explore the extent to which other adolescent health indicators and behaviours have also changed since the turn of the 21st century, trends in a range of indicators are briefly discussed below.

Road crashes

Over the study period the road death rate per capita declined in the population as a whole in the countries of interest, with particularly strong declines among adolescents and young adults (Ferguson et al. 2007, McCartt & Teoh 2015, Ministry of Transport 2015, Ahangari et al. 2016). Adolescent driver behaviour (e.g. less driving, less drunk/risky driving, and more seat belt wearing) appear to have contributed to these trends (Shults & O'Malley Olsen 2012, Adolescent Health Research Group 2013, Shults & Williams 2017).

Interestingly, after decades of decline, the trend in road deaths per capita in all four countries has reversed since a low point in 2013 (NZ and UK) or 2014 (Australia and USA). Research exploring the reasons for this recent rise in road deaths is still at an early stage, but decreasing fuel prices and warmer weather conditions appear to have contributed (Robertson 2018, Best & Burke 2019).

Crime and delinquency

Crime has fallen since the turn of the century in many high-income countries, with a juvenile crime declining particularly steeply in each of the countries of interest (Farrell et al. 2014, Roeder et al. 2015, Berghuis & Waard 2017, Grucza et al. 2017). Related indicators such as prevalence of conduct problems (Keyes et al. 2017) and physical fighting (Pickett et al. 2013, Salas-Wright et al. 2017) have also shown strong declines.

Nutrition

Most adolescent nutrition indicators (e.g. the proportion meeting fruit and vegetable intake recommendations) have not improved over the study period, and adolescent obesity has been stable or increasing in the countries of interest (Ogden et al. 2016, Abarca-Gómez et al. 2017, Ministry of Health 2017, Dunford & Popkin 2018). An exception is the consumption of sugar sweetened soft drinks, which has declined in many countries.

Physical activity

Following a significant decline in cardiovascular fitness of adolescents in high income countries between 1980 and 2000, trends in adolescent fitness have shown no improvement since 2000 (Tomkinson et al. 2017). Meanwhile screen time has increased markedly (Bucksch et al. 2016) and the proportion of adolescents who are sedentary has also increased (Nelson et al. 2006, Ministry of Health 2017).

Mental health

A major review of international adolescent mental health trends concluded that recent cohorts, particularly girls, are more likely to experience anxiety and/or depression compared with earlier cohorts (Bor et al. 2014). Included studies used diagnostic interviews or a formal questionnaire to assess mental health symptoms in population samples, and therefore the results cannot be explained by trends in help-seeking or diagnosis. The findings are also supported by more recent studies showing and increase in self-harm, depressive symptoms and/or anxiety among adolescents since the turn of the 21st century (Wise 2016, Patalay & Gage 2018, Keyes et al. 2019).

Discussion

This chapter describes a seismic shift in adolescent behaviour, international in scope and encompassing a wide range of risk behaviours including tobacco, alcohol and illicit drug use, sexual activity, driving behaviour, crime and delinquency. Large and rapid declines in the prevalence of these behaviours have been observed in New Zealand, Australia, England, the USA and many other high-income countries since the late 1990s or early 2000s. Patterns in the timing and distribution of these behaviour changes may provide some clues as to the possible drivers.

Firstly, it is clear that young people have not become 'healthier' across the board, since today's adolescents are more likely to be sedentary and have mental health problems than those of the 1990s, and the proportion meeting physical activity guidelines or using condoms consistently has declined since the turn of the century. Therefore, it is unlikely that the changes observed are driven by young people becoming more concerned about health risks or more responsive to health promotion messages in general. Nor does a trend towards 'healthy living' appear to explain the decline in risk behaviours.

Declines in risk behaviours have occurred in adolescents of both sexes, all main ethnic groups, and all socio-economic groups, though not necessarily evenly. There have been minor, if any, lags in declines between high and low socio-economic groups. This tends to suggest universal environmental changes, rather than advances in medical knowledge which tend to influence behaviour in high socio-economic groups more quickly and profoundly (Aizer & Stroud 2010).

An interesting finding is that adolescent and adult indicators appear to have mirrored one another closely until the early to-mid 1990s, when they began to diverge (at least for smoking, alcohol use and fertility). This suggests that drivers of risk behaviour change decline are either specific to young people, or are affecting young people differently from adults. The patterns suggest that adolescents are not simply emulating changing adult norms.

The fact that the prevalence of all the behaviours of interest has declined strongly over the past decade could suggest a unitary trend in risk behaviour as a whole, with underlying factor(s) driving trends in all of these indicators simultaneously. On the other hand, the timing of the peak or 'turning point' for each specific behaviour, though generally similar between countries, differs between behaviours. For example tobacco use peaked in the mid to late 1990s in all four countries of interest, whereas some alcohol indicators (e.g. frequency of

drinking occasions and quantity consumed per occasion) did not peak until 6-8 years later in New Zealand, England and Australia. Furthermore, several European countries have observed declines in some risk behaviours but not others. In Demark, for example, lifetime cannabis use has declined substantially in 15-16 year olds since 1999, whereas prevalence of binge drinking remains very high with no significant decline (ESPAD 2014). These patterns seem to provide evidence against the 'unitary trend' hypothesis and suggest that there may also (or instead) be specific drivers for specific behaviours underlying the observed trends.

The fact that substance use and teen pregnancy trends are so similar across the four countries of interest is another striking feature of the data. It is surprising given the differing policy and regulatory contexts in the four countries. For example, England introduced its National Teenage Pregnancy Strategy in 2000, and recent declines in teen births in England have been attributed to the success of this strategy (Skinner & Marino 2016). Yet New Zealand and other countries have observed similarly steep declines in teen births without any such strategy or programme in place. This puts into question whether England's strategy was really responsible for declining teen birth rates in that country and suggests the declines might have happened anyway.

Similarly, the rise in adolescent smoking in the US in the 1990s has been attributed to a real fall in tobacco prices in the early 1990s coinciding with heavy tobacco marketing towards youth (Johnston et al. 2016). The subsequent decline in teen smoking has been put down to a subsequent rise in tobacco prices, in particular a Federal tax imposed in 2008, alongside tighter restrictions on tobacco marketing (Johnston et al. 2016). However these factors cannot explain the almost simultaneous rise and fall in teen smoking also seen in New Zealand and Australia. In these countries real tobacco prices *increased* substantially in the 1990s (when adolescent use was increasing) and were stable in the 2000s (when adolescent smoking was falling sharply) suggesting price was not a major driver in Australia and New Zealand. Furthermore, both New Zealand and Australia had already banned most forms of tobacco marketing by the early 1990s, so marketing restrictions cannot have been the trigger for the sudden reversal of adolescent smoking trends in the late 1990s. These findings suggest that specific policy or law changes are probably not the main drivers of smoking decline. Could broader sociocultural changes be responsible for similar trends in countries with dis-similar policy settings?

If broad socio-cultural influences are more likely than policy changes to explain declines in adolescent risk behaviours, this begs the question 'what are the factors that influence young

people in many high-income countries simultaneously?' Possible answers include technology changes (in particular digital communication and entertainment technology), changes to the global economy (in particular the global financial crisis), and youth culture (e.g. movies, music, celebrities) which has become increasingly globalised in recent decades. However, if any or all of these factors underlie the sea change in adolescent risk behaviour, why then has substance use not declined to a similar extent in the 'outlier' countries such as Italy and France?

It is well established that risk behaviours tend to cluster. As discussed in Chapter 2, one hypothesised explanation, the gateway hypothesis, states that engaging in one risk behaviour opens the door to engaging in others. It could be argued that the staged nature of the observed declines in risk behaviour supports this theory, with the decline in tobacco use leading a cascade effect on other risk behaviours. However, the order in which the various risk behaviours began to decline does not fit well with the logic of the gateway hypothesis. It is often considered that alcohol is the primary gateway for risk behaviour, due to its disinhibiting effects (Barry et al. 2016), and yet some alcohol indicators were among the last of the risk behaviour indicators examined to decline (at least in New Zealand and England). Having said that, the decline in alcohol use (early to mid-2000s) corresponds with declining juvenile arrest rates and an acceleration in the decline in teen births and abortions, and a continuing decline in tobacco use. It is possible that other factors were responsible for the initial declines in smoking and cannabis use prevalence, but subsequently declining alcohol use (in particular binge drinking) has played a causal role in the overall (continuing) decline in risk behaviour (including smoking) since the mid-2000s.

An alternative explanation for the clustering of risk behaviours is 'common liability', that is, there are factors that make individuals vulnerable to risk behaviours in general. As discussed in Chapter 2, there is a large body of research that has established a set of 'shared risk/protective factors' which underlie a range of risk behaviours, e.g. family connectedness, school attachment and childhood adversity. These are obvious candidates to consider as possible drivers of a unitary trend in risk behaviours as a whole. What is interesting is that these shared risk factors underlie both mental health problems and risk behaviours. Therefore it is surprising that, at the population level, trends in mental health and risk behaviours are going in opposite directions. We would expect these indicators to travel together. Does this mean that common underlying factors are *not* the key driver of risk behaviour declines? Or could negative influences on mental health have over-ridden the positive effects of common factors?

To date, much scholarship on adolescent risk behaviour has focused on a single behaviour and/or a single country. A strength of the approach I have taken, looking at a wide range of adolescent behaviours in a number of different countries is that it reveals an international megatrend in adolescent risk behaviour, particularly in relation to substance use, and begins to map the geographical and behavioural extent of that trend. It also highlights outliers – countries and behaviours that do not conform to the general trend. Such observations provide some clues as to possible causal factors, but cannot provide definitive answers, and they raise many additional questions. The questions raised and hypotheses presented above will be revisited and further explored in the following chapters.

CHAPTER 4: LITERATURE REVIEW

I'm in the middle without any plans

I'm a boy and I'm a man

(Song lyrics, 'I'm Eighteen', Alice Cooper, 1970)

Introduction

As the previous chapter demonstrates, there is clearly 'something going on' with adolescent behaviour. How can we explain the international phenomenon of declining risk behaviour? This chapter critically reviews the academic literature that has explicitly addressed that question. The aim is to draw together previously published material about the possible drivers of recent population-level declines in adolescent risk behaviours, evaluate the quality of the evidence, and identify areas of consensus, areas of debate, and gaps in the literature.

Methods

I have drawn on systematic review principles and methods, as outlined in the PRISMA statement (Liberati et al. 2009), to design a robust and methodical search strategy to identify relevant literature.

The first step was to undertake a scoping phase, using a variety of broad search terms in Google Scholar (e.g. 'adolescent risk behaviour/behavior' AND 'trends') to explore the literature and identify some relevant publications. This enabled me to get a general feel for the literature, and the subject headings and key words used in relevant publications. I then undertook, in consultation with reference library staff, a number of trial searches in Medline, refining the search terms to improve the relevance of results incrementally.

Based on the findings of the scoping stage I developed objectives, a final search strategy and inclusion/exclusion criteria as outlined below and in Table 6.

Objectives

- To identify scholarly literature **directly aimed at** explaining/understanding the declining prevalence of adolescent risk behaviours (in particular smoking, drinking, drug use, sexual behaviour) in high-income countries from the late 1990s to the present.

- Within the literature identified above, to identify population-level interventions, exposures, social changes or changes in the composition of the population that have been empirically associated with changes over time in adolescent risk behaviours at the population level.
- To evaluate the quality of the evidence for the explanatory hypotheses put forward in the literature.
- To identify areas of consensus, areas of debate, and gaps in the literature.

Search strategy

My search strategy comprised four main components:

1. Medline search
2. Google and Google Scholar searches
3. Forward and back searching
4. Contacting key authors, and hand searching key websites

Medline search

A Medline search was undertaken on 9 April 2018 using the following search strategy:

Database: MEDLINE Pending, Ovid MEDLINE(R) <1946 to Present with Daily Update>
Search Strategy:
---
1 ADOLESCENT/ (1851863)
2 ('risk* behaviour*' or 'risk* behavior*').mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (19629)
3 CANNABIS/ (7814)
4 Cannabis Smoking/ (3998)
5 Cannabis Abuse/ (5525)
6 Street Drugs/ (9850)
7 CIGARETTE SMOKING/ or TOBACCO SMOKING/ or SMOKING/ (131899)
8 'TOBACCO USE'/ or TOBACCO/ (29088)
9 Sexual Behavior/ (50444)
10 'early sexual'.mp. (1005)
11 COITUS/ (6988)
12 Unsafe Sex/ (4168)
13 Contraception Behavior/ (7194)
14 Pregnancy in Adolescence/ (7407)

15 alcohol drinking/ or binge drinking/ or underage drinking/ (61824)
16 'multiple risk behavio*r*'.mp. (171)
17 Substance-Related Disorders/ (88382)
18 'substance use'.mp. (26421)
19 substance misuse.mp. (1945)
20 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 (382237)
21 trend*.mp. (326591)
22 declin*.mp. (294196)
23 21 or 22 (594601)
24 1 and 20 and 23 (6258)
25 exp ADULT/ (6499614)
26 exp AFRICA/ (232043)
27 exp ASIA/ (704241)
28 24 not 25 (1624)
29 28 not 26 (1573)
30 29 not 27 (1432)
31 limit 30 to (humans and last 10 years) (602)

Note that, where possible, MeSH (Medical Subject Headings) were used rather than keywords, since these capture synonyms and different spellings. For example, the MeSH term 'cannabis' includes marijuana, marihuana, hashish, ganja, hemp etc. Where keywords were used, they are marked .mp in the search strategy above.

The search strategy was based on three constructs: [age group of interest] + [behaviours of interest] + [trends]. The scoping stage revealed that there were no search terms that would limit the results to publications aiming to explain or understand the *causes* of recent trends. Attempts to include such terms invariably excluded relevant material and did little to filter irrelevant material, therefore I opted for the inclusive search strategy detailed above.

This search identified 602 potentially relevant items. The titles and abstracts were screened, and 46 publications were selected for full text review. A further 71 potentially relevant abstracts were identified for full text review via the methods described below.

Google searches

I undertook Google and Google Scholar searches using various combinations of search terms such as 'adolescent' 'teen' 'youth' 'risk' 'risk behaviour' 'substance use' 'sexual behaviour', 'trends', 'explain' 'understand' etc. Google was used to identify government and NGO reports

outside the academic literature, and also media coverage of new research findings (which I followed up, where relevant, locating the publication on which media reports were based). Google Scholar was used to identify academic publications including journal articles and books.

The search terms I used relate to broad and widely researched areas and, as mentioned above, no specific terms exist that enabled me to narrow the search to those publications specifically focused on explaining population trends over time. Therefore the number of items returned was large with low specificity. For example, searching 'adolescent' 'alcohol' 'trends' returned 230,000 results since the year 2000 in Google Scholar; 'adolescent' 'tobacco' 'decline' returned 98,300, and 'understanding' 'decline' adolescent' 'trend' returned 287,000.

Rather than attempt to systematically screen very large numbers of items (which was not feasible given time constraints) I took the approach of using numerous broad searches, and screening the first 30-50 items returned with the aim of identifying 'target' publications. Forward and back searching was then used to identify further relevant publications.

Forward and back searching

'Back searching' involved scanning the reference lists of key relevant publications to identify further relevant research that had been cited in those publications. This ensured that any seminal, highly cited, work would be identified. 'Forward searching' involved using the 'cited by' function in Google Scholar to find and scan a list of publications that had cited a key publication. This was useful for identifying recent publications that built on previous seminal publications.

Contacting key authors and hand searching

I hand searched the websites of research groups, authors and institutions known to have a focus on adolescent risk behaviour and its changing social context. Examples are the Nuffield Foundation and its 'Changing Adolescence' programme in the UK; Massey University's SHORE & Whariki Research Centre in New Zealand; Dr Margreet de Looze (Utrecht University, Netherlands); Assoc Prof Richard Grucza (Washington University School of Medicine, USA); and Dr Michael Livingston (La Trobe University, Australia).

Having identified a small number of researchers actively publishing about the recent decline in adolescent risk behaviour, I contacted them by email to enquire about other publications and researchers working on similar research. This did not result in the identification of any

additional material, suggesting that my search strategy was robust and did not omit important authors or publications.

Table 6: Inclusion and exclusion criteria for literature review

Element	Included	Excluded
Study aim	Aim of the publication/study is explicitly to explore/ explain/understand why adolescent risk behaviours are declining at the population level over time, e.g. it tests specific hypotheses empirically, and/or reviews the evidence for various hypotheses	Studies/publications with other aims
Population of interest	Adolescents (11-19 years) in high-income countries, with a particular focus on secondary school students under the school-leaving age (i.e. 12-15 years) Studies with a broader age range were included, provided results for adolescents were reported separately	Studies with a broader age range in which findings for adolescents were not reported separately
Intervention/exposure Undefined since the purpose is to identify interventions, exposures, social changes or changes in population composition that may explain changes over time in adolescent behaviour	Any	None
Outcomes	Population-level changes (international, national or state level) in adolescent risk behaviour, in particular prevalence of: • smoking and/or • alcohol use and/or • binge drinking and/or • cannabis use and/or • early sexual debut and/or • sexual activity (i.e. sexual intercourse in previous three months)	Study focuses exclusively on other outcomes (e.g. crime, road crashes, deliberate self-harm)
Study design	Observational empirical	Editorials

Element	Included	Excluded
	research; evidence-synthesis, systematic review, scholarly review Study is based on a nationally representative sample, or state representative sample	Evaluation research Speculation about possible explanations for observed trends within introduction and discussion sections of descriptive publications Studies based on trends at school, region, county, or city level
Timeframe	At least a 10-year overlap between the time period covered in the study and my period of interest (1990-2017)	Less than 10 year overlap (e.g. 1975-1999 would be excluded as only 9 years is within period of interest)
Publication type	Peer reviewed journal articles Book chapters Books Refereed conference proceedings Government or NGO reports Theses	Other non-peer reviewed articles (e.g. in news media)
Publication date	2000 or more recently	Prior to 2000

Selection of texts

After review of full texts and application of the inclusion and exclusion criteria, 57 texts were selected for inclusion.

Results

Determinants of declines in many risk behaviours

When I began my doctoral project in early 2016, I was only able to identify one publication that acknowledged a general decline in adolescent risk behaviour across many behavioural domains and discussed the possible causes of this population-level shift. It was a summary document, outlining the findings of a roundtable discussion called by the UK Government Chief Scientific Advisor. In it, academics, practitioners, policy officials and young people were invited to share their knowledge and discuss the available evidence on the possible causes of the observed shift in adolescent behaviour (UK Cabinet Office 2015). Since then, a small

number of additional publications have emerged that explore possible drivers of a broad population-level change in multiple adolescent risk behaviours. These are based on evidence from the USA (Grucza et al. 2017, Harris 2017, Twenge 2017, Arnett 2018), England (Lessof et al. 2016), New Zealand (Lewycka et al. 2018) and Australia (Toumbourou et al. 2018a). Several authors acknowledged that other high-income countries have also observed similar changes in youth behaviour.[6]

However, only one study investigated declining risk behaviour as an international phenomenon: it tested the hypothesis that increasing electronic media communication was a causal factor in concurrent declines in substance use (alcohol, tobacco, cannabis) across Europe and North America in the early 21st century (de Looze et al. 2019). De Looze et al and Grucza et al (2017) are the only publications that empirically test causal hypotheses. The other publications provide evidence-informed discussion about possible determinants of declining risk behaviours (UK Cabinet Office 2015, Arnett 2018, Lewycka et al 2018); or describe and explain why today's young people are as they are, via a narrative that draws on repeat cross-sectional survey data and evidence of the changing social context (Lessof et al 2017, Harris 2018, Twenge 2018). The included publications are detailed in Table 7.

Table 7: Literature exploring determinants of declines across many risk behaviours

Author (date)	Title	Country Type of publication	Type(s) of evidence presented
UK Cabinet Office (2015)	What is happening to children and young people's risk behaviours?	UK Brief report summarising a roundtable discussion chaired by the Government Chief Science Advisor	Expert opinion Temporal correspondence of trends
Lessof et al. (2016)	Longitudinal Study of Young People in England Cohort 2: Health and wellbeing at Wave 2	England Research report	Repeat cross-sectional survey data, 2005 & 2015. Temporal correspondence of trends
Grucza et al (2017)	Declines in prevalence of adolescent substance use disorders	USA Peer reviewed journal article	Trend analysis based on repeat cross-sectional survey data, 2003-

[6] Arnett (2018) and Toumbourou et al (2018) are exceptions. They argue that dramatic declines in adolescent risk behaviours are particular to the USA and Australia respectively.

Author (date)	Title	Country Type of publication	Type(s) of evidence presented
	and delinquent behaviours in the USA: a unitary trend?	Original research	2014. Item response theory modelling to test for underlying latent variables
Harris (2017)	Kids these days: Human capital and the making of Millennials	USA Book	Collated administrative and survey data from a range of sources, and illustrative vignettes
Twenge (2017)	iGen: Why today's super-connected kids are growing up less rebellious, more tolerant, less happy – and completely unprepared for adulthood	USA Book	Collated administrative and survey data from a range of sources, and illustrative vignettes
Arnett (2018)	Getting better all the time: Trends in risk behaviour among American adolescents since 1990	USA Peer reviewed journal article Viewpoint	Discussion of plausibility of various hypotheses for the decline in risk behaviour, drawing on existing evidence
Lewycka et al (2018)	Downward trends in adolescent risk-taking behaviours in New Zealand: Exploring driving forces for change	New Zealand Peer reviewed journal article Viewpoint	Discussion of plausibility of various hypotheses for the decline in risk behaviour, drawing on existing evidence
Toumbourou et al (2018a)	Explaining reductions in secondary school age youth alcohol and drug use in Australia	Australia Research report	Aggregation of expert opinion
De Looze et al (2019)	The decline in adolescent substance use across England and North America in the early twenty-first century: A result of the digital revolution?	42 countries in North America & Europe Peer reviewed journal article. Original research	Country-level analysis of correlation between trends in exposure and outcome

There was consensus in the literature that the observed changes in adolescent risk behaviour represented real changes in behaviour and not merely changes in social desirability bias or

reporting methods. However, there was disagreement or uncertainty about the universality of the trend. A key question raised in the UK Cabinet Office report was whether overall trends were masking different trajectories in vulnerable subgroups. For example, according to this report, rising alcohol-related deaths and hospital admissions occurred in England over a period when overall alcohol use was declining, suggesting that risky drinking may have increased in certain subgroups. It states:

> *Whilst we know that risk behaviours are in decline overall, we cannot be sure if the same can be said for the most vulnerable…[W]e don't appear to know if the 'core' of children engaged in multiple and severe risk behaviours is growing or if their outcomes are getting worse (UK Cabinet Office 2015, p 4).*

In contrast, US authors provide evidence that the group engaged in multiple and severe risk behaviours is shrinking, and that risk behaviours are declining in vulnerable groups as well as the adolescent population as whole. Twenge, for example, observes that although risk behaviours remain strongly patterned by demographic factors, *declines* in risk behaviours have occurred across all main subgroups of the US adolescent population by race, gender, socio-economic status, and geographic area (Twenge 2017). Analysis by Grucza et al shows that between 2003 and 2014 the size of the group of 12-17 year olds with severe risk behaviours declined by 49% for diagnosable substance use disorders, and 34% for delinquent behaviours[7] (Grucza et al. 2017).

It was widely agreed in the literature that the similarity of trends across a number of behavioural domains and outcomes was suggestive of common underlying causes, and that the drivers were likely to be multifactorial (UK Cabinet Office 2015, Twenge 2017, Lewycka et al. 2018). A wide range of hypothesised common causes were presented. For example, most authors discussed changes in parenting, the economy, and the digital revolution (i.e. the rise of the internet, social networking, and online gaming) as possible causal factors, although the degree of emphasis on each and the way these factors were characterised differed between authors. Other themes less widely discussed were public policy interventions, changing social norms and role models, and increasing pressure on young people to succeed at school. The evidence cited was generally temporal correspondence of changes in hypothesised causal factors with declines in adolescent risk taking, and a plausible mechanism of influence.

[7] The delinquent behaviours comprised handgun carrying, selling drugs, stealing an item worth $50 or more, group fighting, and attacking a person with intent to injure.

Displacement by digital media

Twenge (2017) posits the emergence of virtual socialising as the primary driver of declining risk behaviour, combining with 'overprotective' parenting to shift teens' time use towards supervised time at home rather than going out with friends. This argument is backed up with trend data from US repeat cross sectional surveys (primarily the Monitoring the Future survey), for example demonstrating changes over time in adolescents' time use; parental monitoring; and declining prevalence of spending time at home with no adult present. Arnett (2018) also considers that the rise in electronic media use is the most plausible explanation for the decline in adolescent risk behaviour in the USA. He bases his argument on quantitative evidence of rapidly increasing use of screen-based media since the early 1990s, and the logic that:

> *Adolescents who are watching YouTube clips or playing online electronic games with friends while alone in their bedrooms are not simultaneously taking part in the unstructured socialising that is often the launching pad for risk behaviour (Arnett, 2018, p92).*

Whereas Twenge and Arnett cite detailed evidence demonstrating the rise in electronic media use among US adolescents to back up the displacement hypothesis, it is presented more speculatively by other authors (UK Cabinet Office 2015, Lewycka et al. 2018, Toumbourou et al. 2018a). Both Lewycka et al and Twenge note that the rapid adoption of new communication and information technologies in all high-income countries might explain the almost simultaneous declines in risk behaviours internationally.

Arnett (incorrectly) claims that the cross-sectional association between digital media use and risk behaviours has yet to be investigated. In fact, as outlined in Chapter 2, and further discussed later in this chapter, there is consistent evidence of a *positive* relationship between digital media use and substance use at the individual level. This evidence undermines the digital media displacement hypothesis since if digital media use was displacing risk behaviours then we would expect those who spend more time online to be less prone to risk behaviours. Yet there is consistent evidence, using a variety of measures of digital media engagement in a range of countries, that the opposite is the case (Iannotti et al. 2009, Gommans et al. 2015, Meldrum & Clark 2015, Durkee et al. 2016). However, an important potential confounder that none of these studies adjusted for is sociability. Are sociable young people more likely both to engage in risk behaviours, and to be very active online? And could a negative relationship

between electronic media use and risk behaviour trends exist at the population level, despite a positive relationship at the individual level?

De Looze et al (2019) tested both of these possibilities using HBSC data from 26 European and North American countries, 2002-2014. The results showed that, at the country level, there was no association between trends in electronic media communication and trends in substance use (weekly smoking, weekly alcohol use, and lifetime cannabis use) over the study period. This is consistent with the findings of Chapter 3 which identified 'outliers' among high-income Western nations in which risk behaviours had not declined, despite apparently similar exposure to broad contextual factors, including the rise of digital media use. Nor did the authors find that national trends in electronic media communication were associated with trends in face to face contact with friends in the evening, providing further evidence against the displacement hypothesis (de Looze et al. 2019).

However, de Looze et al did find that face to face contact with friends had declined over time in many countries. They also found a statistically significant positive association between face to face contact with peers in the evening and substance use at the national level. Thus they concluded that decreasing face to face contact with peers, but not increasing electronic media communication, has played a role in recent declines in adolescent substance use (de Looze et al. 2019).

De Looze et al also examined cross-sectional relationships between substance use and electronic media communication in 2014, using pooled HBSC data from 34 countries and adjusting for face to face contact with friends in the evening (which can be seen as a measure of sociability) and other covariates: age, gender and family affluence. They found that, at the individual level, sociability partially explained the relationship between electronic media communication and substance use. But even in fully adjusted models, the positive association between electronic media communication and substance use remained statistically significant (de Looze et al. 2019).

This finding supports the view, expressed by several authors, that internet use could potentially *exacerbate* 'traditional' risk behaviour, and/or create new risks (UK Cabinet Office 2015, Lewycka et al. 2018, de Looze et al. 2019). For example, the UK Cabinet Office report comments that the internet may make access to 'designer drugs' easier, and notes that a correlation has been observed between online and offline risk behaviours in adolescents, which is suggestive of common underlying causes for both rather than a displacement effect.

It also highlights 'digital immersion' as a likely cause of declining physical activity in English adolescents, and notes that excessive internet use could be seen as a risk in its own right, and classified as an addiction (UK Cabinet Office 2015).

De Looze et al note that those spending more time online are likely to be exposed to more pro-substance-use content, including both alcohol advertising and 'user generated content', i.e. young people posting images, videos or text that present substance use in a positive light (de Looze et al. 2019). This might help to explain the positive association between electronic media communication and substance use, but (as far as I am aware) is yet to be tested. Taken together, the empirical evidence provides more support for the 'exacerbation' hypothesis than the 'displacement' hypothesis; the evidence suggests that risk behaviours are declining *in spite of*, not because of, the fact that young people are spending more time online.

Growing up slowly or growing up quickly? The economic context and the changing social meaning of adulthood

Twenge (2017) argues that today's teenagers are growing up more slowly. She contrasts them with previous generations who, by their mid-teens, were eager to experience the perceived pleasures and freedoms of adulthood (e.g. driving, sex, alcohol). She claims adults now treat adolescents as children and teens themselves are eschewing traditional 'rites of passage' in favour of the emotional and financial support their parents offer, and a largely online (rather than face to face) social life. She bases these claims on trend data showing adolescents are increasingly delaying getting a drivers licence, becoming sexually active, drinking alcohol and working for pay.

She also cites evidence of increasing 'maturity fears' among teenagers and young adults. For example, survey data shows young people entering college in the USA are more likely than their counterparts in the 1980s or 1990s to agree 'I wish that I could return to the security of childhood' and less likely to agree 'I would rather be an adult than a child.' She also notes that since about 2014 'adulting' has been used as a verb, and (based on the way it is used in social media posts) 'it seems to mean the end of all fun' (p 46). She suggests that the social meaning of childhood and adulthood have changed, such that the former (associated with less stress and more fun) is now more desirable in the eyes of young people. She argues that this 'slow life strategy' is a response to the social and economic context of 21st century America. However, she downplays the role of macroeconomic and labour market forces, characterising the fall in youth employment as largely driven by teenagers' choice not to seek work. She dismisses the global financial crisis of 2008/09 as a major factor in the decline of adolescent

risk behaviour, arguing that adolescent binge drinking, teen pregnancy etc declined both before and after the global financial crisis, continuing to trend down strongly after the US economy had ostensibly recovered.

Lewycka et al (2018) also argue that macroeconomic factors are unlikely to have played a major role in the observed declines in risk behaviour in New Zealand, since many of the large declines in teen risk behaviour occurred before the global financial crisis, which, in any case (they argue), did not affect New Zealand as greatly as many other OECD nations. They also note that, although income inequality is a key determinant of health, it has been relatively stable in New Zealand over the past two decades and therefore increasing income inequality does not appear to be a driver of declining risk behaviour in adolescents since 2000 (Lewycka et al. 2018). A possible criticism of these analyses is that they take a rather narrow view of economic drivers and rely on economic indicators such as gross domestic product, general unemployment and measures of income inequality that do not necessarily capture the way structural economic changes of recent decades have affected, and continue to affect, young people specifically.

In contrast, Lessof et al. (2016) and Harris (2017) put greater emphasis on economic factors such as the collapse of the youth labour market, the rising cost (and perceived necessity) of tertiary education, greater competition for jobs, and low wage growth as major drivers of a generational change in attitudes and behaviour since the turn of the 21st century in England and the USA respectively (Lessof et al. 2016, Harris 2017).

Based on economic analysis, trend data and illustrative vignettes, Harris's central argument is that childhood and adolescence are increasingly shaped by preparation for engagement in the highly competitive 21st century 'knowledge economy'. He argues that that young people, even pre-schoolers, are increasingly positioned as units of human capital to be maximised. Harris's vignettes seem to illustrate extreme rather than typical scenarios. For example he reproduces a letter sent to primary school parents explaining that that the kindergarten show had been cancelled so that the 5 year old pupils could concentrate on college and career readiness.[8] However such vignettes may be illustrative of a real shift in the meaning of childhood and the

[8] The letter was sent to parents of Harley Ave Primary School in New York, April 2014. The abridged letter reads 'We hope this letter serves to help you better understand how the demands of the 21st century are changing schools… What and how we teach is changing to meet the demands of a changing world. The reason for eliminating the Kindergarten show is simple. We are responsible for preparing children for college and career with valuable lifelong skills and know we can best do that by having them become strong readers, writers, co-workers, and problem-solvers… [K]now that we are making these decisions with the interests of all children in mind'.

perceived purpose of education. There is considerable evidence – particularly from the UK and USA – that educational reforms are putting more emphasis on literacy and numeracy at ever-younger ages, with pressure even on pre-schools to demonstrate effectiveness via pupil assessment (Vukelich & Christie 2009, Purpura & Lonigan 2015). Harris's argument is also supported by a recent UK report recommending that children as young as 2 years old should be introduced to careers education (Millard et al. 2019).

Lessof et al. (2016), based on a comparison of comprehensive surveys of Year 10 students (14-15 year olds) undertaken in England in 2005 and 2014, observed that adolescents had become more 'serious' and 'work focused' over the study period. For example the proportion who reported truanting almost halved between 2005 and 2014, academic aspirations increased, and the proportion equating hard work with success also increased. However the proportion endorsing statements such as 'People like me don't have much of a chance in life' and 'Even if I do well at school I'll have a hard time getting the right kind of job' also increased, suggesting that young people may be increasingly pessimistic about their future prospects. This was particularly the case for groups typically disadvantaged in the job market: e.g. girls, adolescents from low SES neighbourhoods, and some ethnic minority groups.

These analyses imply that, rather than 'growing up slowly' (as Twenge argues), adolescents are in some ways being forced to grow up quickly, forgoing youthful playfulness and experimentation with sex and drugs in the struggle to compete and succeed. Lessof et al (2016) suggest a milieu of anxiety about the future could explain both an observed decline in mental wellbeing of adolescents (particularly girls) and reduced risk behaviour. However Twenge (2017) rejects the argument that young people have become more 'responsible' or pressured to succeed academically, citing time use studies indicating that time spent on homework has stayed steady or decreased since the early 1990s among US adolescents.

Parenting

Several authors highlight changes in parenting that may be influencing declines in risk behaviours. US authors Harris and Twenge both characterise 21st century parents as 'overprotective', since 'if an American parent wants to give their child a chance at success, they can't take any chances' (Harris, 2017, p 6). This involves not only shielding offspring from physical risks via constant supervision, but also maximising their future prospects through extra-curricular activities (from birth), and heavy involvement in ensuring academic success and 'appropriate' choices of peers and activities. Harris argues: 'The result is a generation of children with an unprecedented lack of unsupervised time who have systematically been

denied the chance to build selves without adult oversight' (Harris, 2017, p 6). Twenge notes that US adolescents are now also more financially dependent than teens of the 1990s, with the proportion of high school students who work for pay or get an allowance declining since 2000, and parents increasingly in control of day to day purchasing decisions.

In contrast Australian, English and New Zealand authors frame the parenting changes of recent decades in a more positive light, seeing the increase in parental supervision and monitoring since the 1980s and 1990s as an 'improvement' in parenting. They note evidence of better parent-child relationships and communication (UK Cabinet Office 2015, Toumbourou et al. 2018a) and improvements in family connectedness (Lewycka et al. 2018). They argue that these parenting improvements are likely to have had a protective effect, reducing risk behaviour in multiple domains. It is not clear whether these different perspectives on parenting trends reflect qualitative differences in parenting practices between the countries of interest, or differing interpretations of similar trends. What all of these authors agree on, however, is that today's adolescents spend much less unsupervised time with their friends than young people in previous generations, and that this is a likely driver of the decline in risk behaviour.

Social norms and role models

Lewycka et al (2018) note that family, school and neighbourhood environments play an important role in influencing adolescent behaviour, and suggest that changing social norms may have played a role in declining risk behaviour in New Zealand. For example, the authors state: 'Adult drinking, smoking and alcohol related harm has also decreased over recent decades, alongside cultural shifts in media coverage and levels of approval around alcohol and smoking' (p 5). Although it is reasonable to hypothesise that decreased substance use by adult role models might have influenced adolescent trends, whether such changes have actually occurred is debatable. As shown in Chapter 3, adolescent smoking has declined at a much faster rate than adult smoking since the turn of the century, and hazardous drinking among adults has actually *increased* in the countries of interest over the past 10 years. Studies show that, as a result, alcohol-related harm has increased, not decreased, in recent years (Stewart et al. 2014, Green et al. 2017).

Evidence of cultural shifts in the acceptability of smoking and drinking is more convincing. For example, Lewycka et al (2018) cite evidence that the portrayal of alcohol in the news media in Australia has become more disapproving since 2000 (Azar et al. 2014). This fits with evidence of increasing concern about alcohol harm in the Australian general population (Livingston &

Callinan 2017). Whether media portrayal and social concern about alcohol has also changed in the other countries of interest is still to be empirically investigated, but is plausible. Certainly the social acceptability of smoking has declined over recent decades in most high-income countries (Hammond et al. 2006, Chapman & Freeman 2008), likely influencing adolescent behaviour. Yet tobacco denormalisation, which began in the 1960s, did not prevent the rise in adolescent smoking observed in the early 1990s.

When Australian stakeholders working in the youth drug and alcohol field were asked about the reasons for the decline in adolescent substance use in Australia, the explanatory factor most commonly identified was an increase in community awareness of the harmful effects of alcohol and other drugs. This increase in awareness was believed to be related to new research (e.g. linking even moderate drinking with increased risk of cancer, and suggesting adolescent substance use may affect brain development), greater availability of evidence-based information, and revised Australian national health guidelines in 2009 recommending school-aged adolescents do not use alcohol at all (Toumbourou et al. 2018a). It is important to note that these findings are based on the perceptions of academics and practitioners involved in alcohol education and prevention.

Public policy and public health interventions

Having evaluated the plausibility of a range of hypotheses, Lewycka et al (2018) conclude that public policy and public health interventions, in particular social marketing and mass media campaigns, were likely to have played an important role in the decline in adolescent risk behaviour in New Zealand, 2001-2012. This is based on a timeline of policy changes and campaigns in relation to smoking, alcohol and risky driving during the 2001-2012 period, and the assertion that there is growing international evidence that such policies and interventions can be effective. However Lewycka et al do not provide any direct evidence (e.g. from policy evaluations) of the impact of the listed policies and campaigns on the prevalence of adolescent risk behaviour in New Zealand.

Toumbourou et al (2018a), based on stakeholder perceptions, also posit that public policy, health promotion and drug education initiatives were major factors in concurrent declines in adolescent smoking, alcohol and other drug use in Australia. Almost half of the 27 respondents felt that improved drug education in schools was an important factor, e.g. a broader focus on life skills and refusal skills, and recent national efforts to increase teacher capacity. However, as the respondents were selected based on their involvement in the field of drug and alcohol prevention, it is possible that their professional roles may be a source of a

bias. It must also be noted that the study was funded by the Alcohol and Drug Foundation, a provider of drug education.

In contrast, Arnett (2018) considers but rejects the idea that declining risk behaviour represents a triumph of public policy, arguing there have been no major new policy initiatives in the past 10 years, yet risk behaviours among American adolescents have continued to plummet. He also points out that some of the initiatives most widely funded and implemented in the USA, such as 'abstinence only' sex education and substance abuse prevention programmes such as DARE (drug abuse resistance education), have been shown to be ineffective or even harmful, yet risk behaviour has declined anyway. Arnett's conclusion is supported the international evidence regarding the effectiveness of prevention initiatives, which (as discussed in Chapter 2) is decidedly mixed. While there is evidence that such interventions *can* be effective, there are many studies that show that specific policy measures have had little or no effect on adolescent risk behaviours (Batis 2017, Courtemanche et al. 2017, Kuipers et al. 2017, Manivong et al. 2017). Therefore it is not reasonable to assume that because policies or interventions have been implemented, *ipso facto,* they have resulted in population level behaviour change.

Alcohol, smoking and drug prevention efforts date back many decades, and early efforts were notoriously unsuccessful (Thompson 1978, Kinder et al. 1980, Flay & Sobel 1983). Although more recent reviews show that preventive interventions *can* influence behaviour (Wakefield et al. 2010, Brinn et al. 2012, Catalano et al. 2012), effects tend to be short term and small in magnitude (Wiehe et al. 2005), and therefore do not necessarily make an impact at the population level. For example, trend data shows prevention efforts were particularly unsuccessful during the 1990s, when prevalence of adolescent substance use increased markedly despite concerted public health action. Both Lweycka et al and Toumbourou et al note that recent initiatives are based on a more sophisticated understanding of the determinants of adolescent behaviour, and therefore they are likely to have been more effective. This may be the case, but given their ineffectiveness in previous decades it seems unlikely that such efforts have been the major cause of the dramatic shifts in adolescent behaviour observed over the past 15-20 years. However, it is likely that they have contributed to awareness of the harms associated with adolescent tobacco and alcohol use.

Other themes

The report on Australian stakeholder perceptions was the only publication to suggest a knock on effect from one risk behaviour to another. According to this report there was wide

stakeholder agreement that declining smoking (both among adults and young people) may have resulted in adolescents having less favourable attitudes towards alcohol and other drug use (Toumbourou et al. 2018a). This assertion was underpinned by the gateway hypothesis, but the causal mechanisms were not discussed.

My discussion of contextual changes in Chapter 2 highlighted the exclusion of teenagers from public space via policy and design measures over the past 20-25 years. However Harris (2017, p190) was the only author to discuss this theme, suggesting that lack of public space and increased surveillance may have contributed to the decline in adolescent risk behaviour.

Grucza et al (2017) take a rather different tack from the other publications, and focus on testing the hypothesis that the decline in substance use disorders and serious delinquency represent a 'unitary trend' in an underlying latent variable. They confirmed this hypothesis empirically using repeat cross-sectional nationally representative US data on substance use and delinquent behaviours and contextual factors in 12-17 year olds, 2003-2014. Modelling based on item response theory showed that declines in 12 indicators largely reflected a trend in a latent 'externalising-like' trait,[9] rather than multiple trends in specific behaviours. In the discussion the authors speculate about three possible underlying causes, none of which were mentioned in the other publications. They are: a rapid reduction in childhood lead exposure; increased use of psychotropic medications (e.g. Ritalin) in children and adolescents with behavioural problems; and declining rates of child maltreatment, with evidence of US trends cited for each. The authors hypothesise a causal relationship based on the temporal correspondence of trends.

However a closer examination calls into question the temporal correspondence between changes in exposure to lead and psychotropic medication and the international decline in risk behaviour since about 2000. In the USA, New Zealand and Britain most of the decline in lead exposure occurred between the mid-1970s and mid-1980s (Hinton et al. 1986, Nevin 2007, Grucza et al. 2017), with preschool blood lead levels by the mid-80s well below the likely threshold for behavioural problems (i.e. 15-20 micrograms/dL) (Burns et al. 1999, Lane et al. 2008). This 'should' have resulted in declining risk behaviours in these countries in the 1990s, given that preschool exposure is most strongly associated with later problem behaviour, and yet substance use rose significantly in that decade. Interestingly, estimated preschool blood

[9] Externalising behaviours are responses to stressors that are directed outward such as aggression, vandalism, substance use etc. They can be contrasted with internalising problems in which reactions are turned inwards: e.g. anxiety, depression.

lead levels in Australia fell much more slowly than in the other countries of interest and remained above 15 micrograms/dL until the early 1990s (Nevin 2007), yet Australia has not lagged behind the other countries in declining risk behaviours. In fact Australia has lower prevalence than the other countries of interest on most measures. This lack of temporal correspondence suggests declining lead exposure is *not* the primary factor in declining risk behaviour, but we cannot rule out that it has played a minor role, particularly at the more serious/extreme end of the risk behaviour spectrum.

Similarly the sharp rise in use of stimulant medication for behavioural disorders in the 1980s and 1990s seems to predate the decline in adolescent risk behaviour, even allowing for a lag of several years (Berbatis et al. 2002, Zuvekas et al. 2006). Furthermore, children with behavioural problems represent a relatively small proportion of the population (Howie et al. 2014)[10] so increases in use of medication may explain reductions in risk behaviour in this group, but cannot account for the changes seen in the wider population of adolescents. That does not mean, though, that changes in this subgroup could not have contributed to overall trends. Indeed, in support of this hypothesis, many of the countries with particularly large declines in adolescent risk behaviours (USA, Canada, Australia, Iceland, New Zealand) also have high prevalence of psychostimulant use in children and adolescents (Berbatis et al. 2002, Zoega et al. 2007). However this correlation may reflect a high level of 'problematising' of risk behaviour in young people in these countries at both individual and population levels, rather than a causal relationship.

Various sources of US evidence suggest a decline in exposure to child maltreatment and sexual abuse (Institute of Medicine & National Research Council 2012, Finkelhor et al. 2014) – important established risk factors for adolescent risk behaviour, as discussed in Chapter 2. It is unknown whether declining maltreatment is USA-specific, e.g. possibly due to a decline in the crack cocaine epidemic (Parker & Anthony 2014), or has also occurred in other high-income countries. But this appears to be a possible driver worthy of further investigation. If child maltreatment is declining across many high-income countries, that is good news not only for adolescent risk behaviour but for young people's development, happiness and life chances more broadly.

[10] Howie et al (2014) estimated that 7.5% of US children aged between 6 and 17 were taking medication for 'emotional or behavioural difficulties' in 2011-12.

Determinants of smoking decline

As outlined in Chapter 3, adolescent smoking rose sharply in the USA, New Zealand and England in the 1990s, with Australia also experiencing an increase in the 1990s of a smaller magnitude. In the late 1990s and early 2000s adolescent smoking fell just as sharply, and has continued to decline to record low levels in all four countries. Given the dramatic and longstanding decline in adolescent smoking over the past two decades, surprisingly few studies have attempted to identify the determinants of this trend. Included studies are summarised in Table 8.

Table 8: Literature exploring determinants of adolescent smoking trends

Author (date)	**Title**	**Location** **Type of publication**	**Type of evidence presented**
Charlton & Bates (2000)	Decline in teenage smoking with rise in mobile phone ownership: hypothesis	Britain Research letter	Temporal correspondence of trends at the population level
Koivusilta et al. (2003)	Mobile phone use has not replaced smoking in adolescence	Finland Research letter	Cross-sectional associations at the individual level
Osaki et al (2008)	Decrease in the prevalence of smoking among Japanese adolescents and its possible causes	Japan Peer reviewed journal article Original research	Trends in exposure to risk/protective factors, and population attributable risk
Pampel & Aguila (2008)	Changes in youth smoking, 1976-2002	USA Peer reviewed journal article Original research	Trend analysis, modelling the contribution of predictor variables to the trend
Peretti-Watel et al (2009)	Cigarettes and mobile phones: are they complementary or substitutable products?	France Peer reviewed journal article Original research	Cross-sectional association at the individual level
Sargent (2009)	Comparison of trends for adolescent smoking and smoking in movies, 1990-2007	USA Research letter	Temporal correspondence of trends at the population level
White et al (2011)	What impact have tobacco control policies, cigarette price	Australia Peer reviewed	Individual level associations between

Author (date)	Title	Location Type of publication	Type of evidence presented
	and tobacco control programme funding had on Australian adolescents' smoking?	journal article Original research	predictor variables (including time) and outcomes
Osaki et al (2012)	Mobile phone use does not discourage adolescent smoking in Japan	Japan, Peer reviewed journal article Original research	Cross-sectional association at the individual level
Friedman (2015)	How does electronic cigarette access affect adolescent smoking?	USA Peer reviewed journal article Original research	Comparison of smoking trends at the state level, by exposure to policy variable
White et al (2015)	What is the role of tobacco control advertising intensity and duration in reducing adolescent smoking prevalence?	Australia Peer reviewed journal article Original research	Individual level associations between predictor variables (including time) and outcomes
Dessaix et al (2016)	Factors influencing reductions in smoking among Australian adolescents	Australia Peer reviewed journal article Viewpoint	Evidence synthesis
Pesko et al (2016)	The influence of electronic cigarette age purchasing restrictions on adolescent tobacco and cannabis use	USA Peer reviewed journal article: Original research	Comparison of smoking trends at state level, by exposure to policy
Dutra & Glantz (2017)	E-cigarettes and National Adolescent Cigarette Use: 2004–2014	USA Peer reviewed journal article Original research	Comparison of national trends, pre- & post-exposure

Public policy[11]

The reason empirical studies aimed at explaining the recent decline in adolescent smoking are rare may be because public health interventions are assumed to fully explain the trends. For example a review entitled 'Factors influencing reductions in smoking among Australian

[11] Here and throughout the thesis 'public policy' refers to government action including implementation of social marketing campaigns, behavioural modification interventions, health promotion, regulatory measures etc.

adolescents' (Dessaix et al. 2016) provides a history of tobacco control in that country from 1996 to 2014, outlining measures such as taxation, marketing restrictions, smokefree legislation and mass media advertising. The authors imply that these measures explain the precipitous decline in adolescent smoking. However, the evidence, largely based on temporal correspondence and a plausible mechanism of influence, is generally weak. Other broader factors that could plausibly have impacted on adolescent behaviour (e.g. changes in parenting, adolescents' time use, educational achievement/aspirations etc) are not mentioned in the review.

The most methodologically sophisticated studies cited in the Dessaix et al (2016) review were White et al's studies on the impact of tobacco control policies on youth smoking prevalence in Australia (White et al. 2011, White et al. 2015b). The first investigated the effect of policy implementation in three areas (youth access, clean indoor air, point of sale/outdoor advertising) along with changes in tobacco price at the state level, and national per capita tobacco control spending. It is notable that the largest increase in tobacco prices occurred in the early 1990s, a period during which adolescent tobacco use *increased*; hence bivariate models showed a *positive* association between tobacco price and youth smoking in Australia. In fully adjusted multi-level models, clear air laws had the strongest independent protective effect on adolescent smoking. Tobacco prices and national tobacco control expenditure also had statistically significant protective effects, after adjustment, although effect sizes were small (White et al. 2011). In the second study, White et al found that exposure to tobacco-control advertising – above a certain intensity threshold – also partially explained the decline in adolescent smoking in Australia between 1993 and 2008, after adjusting for other policy factors (White et al. 2015b).

The authors acknowledged that secular, social or economic factors not related to tobacco control may have influenced adolescent smoking over the study period, with the study design unable to fully control for these factors (White et al. 2011). Furthermore, I would argue it is likely that growing social disapproval of smoking contributed to both the strengthening of policy measures and the decline in adolescent smoking. If so, policy changes should be seen as a marker of (and contributor to) tobacco denormalisation rather than (or as well as) having direct causal effects on adolescent smoking (Chapman & Freeman 2008).

Changing social environment

A study conducted by economists in the USA examined changes in youth smoking from 1976 to 2002 based on Monitoring the Future survey data on smoking in 12th grade students (17-18

years) and other data sources. The study used trend analysis, and tested a number of possible explanations. The first covered what the authors call 'compositional changes' i.e. fewer young people in high risk categories such as coming from a single parent family, having parents with low educational attainment, having poor academic performance, having a part time job, having little involvement in church, and going out at night more often. The other potential explanations covered:

- sample selection in school-based studies due to declining dropout rate
- adult smoking prevalence
- 'social strain' indicated by unemployment, suicide, crime and youth violence
- tobacco prices, tobacco marketing and anti-tobacco advertising
- other drug use.

The authors found that the model including 'compositional factors' differed little from the model based on year only, suggesting these factors contributed little to trends over time. They dismissed differential dropout rates as an explanation, found that youth smoking prevalence changed over time independently from adult smoking prevalence, and found neither social strain nor teen unemployment matched trends in smoking. They found that cigarette price only had a significant association with adolescent smoking from the late 1990s (after prices had risen significantly), suggesting a possible threshold effect. They found that advertising – whether pro- or anti-tobacco – correlated only weakly with tobacco use, and 'does not appear central to changes in youth smoking' (p 9). Trends in cannabis initiation and use closely corresponded with those for tobacco, suggesting 'some overlap in attraction to cigarettes and cannabis' (p 9). They found that cigarette prices and cannabis use were most clearly associated with youth smoking trends, but concluded, 'much of the change in youth smoking, particularly the most recent rise and fall, remains unexplained' (Pampel & Aguilar 2008, p 1).

Displacement by mobile phones

Soon after smoking began to decline in the late 1990s, a letter was published in the *British Medical Journal* hypothesising a causal relationship between rising mobile phone use in adolescents and falling rates of smoking, highlighting the temporal correspondence between these two trends (Charlton & Bates 2000). The authors speculated that mobile phones might be competing with cigarettes for adolescents' scarce financial resources, and fulfilling similar functions, i.e. offering 'individuality, sociability, rebellion, peer group bonding, and adult aspiration' (p1155).

There followed a number of studies e.g. from Finland (Koivusilta et al. 2003), Japan (Osaki et al. 2012), and France (Peretti-Watel et al. 2009) refuting this hypothesis with empirical data, and showing a *positive* association between mobile phone use and smoking in adolescents at the individual level, a relationship that remained significant after controlling for a wide range of confounders including income. For example, Osaki et al found a dose-response relationship between monthly mobile phone bill and probability of smoking in Japanese adolescents (Osaki et al. 2012). Koivusilta & Lintonen also found a dose-response relationship between mobile phone use and smoking in Finnish 14, 16, and 18 year olds, with an OR of 7.7 (95% CI: 6.1, 9.9) for those using mobile phones for an hour or more per day compared to those not using a mobile phone at all. A French study of 17 year olds found that the odds ratio for daily smoking in mobile phone owners (compared with non-owners) was 1.4 for boys and 1.8 for girls after adjusting for academic performance, participation in techno parties, family factors and school participation (Peretti-Watel et al. 2009). Peretti-Watel et al (2009) put forward an alternative hypothesis: that the relationship between smoking and mobile phone use was not causal, but rather both reflected a late-1990s youth lifestyle 'characterised by peer-oriented activities, but also by poor parental control and unconventional values' (p 340).

While these studies clearly show that mobile phone use has not displaced smoking at the individual level, they do not necessarily disprove a population-level link between the rise in mobile phone use and the decline in smoking. However, the study by de Looze et al (2019) discussed in the previous section provides evidence against a population-level association (albeit using a measure of electronic media communication rather than mobile phone ownership or use).

Advent of e-cigarettes

There has been recent interest in the USA in the question of whether rising availability and use of e-cigarettes since their widespread introduction in about 2010 has contributed to declining prevalence of combustible cigarette use in adolescents. Studies have produced mixed findings. Friedman used regression analysis to compare smoking prevalence trends (2002-2013) in 12-17 year olds in states that did and did not introduce bans on e-cigarette sales to minors (such bans were introduced by 13 states between 2010 and 2013).The study controlled for state tobacco tax, smokefree air laws, cannabis legalisation, demographic factors, and state and year fixed effects. She concluded that adolescent smoking declined more slowly in states that introduced bans on e-cigarette sales to minors, following their introduction. However adolescent smoking prevalence was higher at baseline and remained higher throughout the

study period in states without bans. Pesko et a (2016) used similar methods and reached the same conclusion: that age restrictions on purchasing electronic nicotine delivery systems retarded the decline in adolescent smoking, relative to states that had not implemented restrictions (Pesko et al. 2016).

These studies suggest that combustible cigarettes and e-cigarettes are substitutable in adolescents, and when access to one is limited consumption of the other increases (or declines more slowly) with the corollary that increasing access to e-cigarettes contributes to a decline in combustible tobacco use. However, an alternative interpretation is that states that did not impose e-cigarette restrictions had higher baseline adolescent smoking prevalence and observed steeper declines simply because smoking rates had further to fall. Other researchers have shown that, at the national level, the introduction of e-cigarettes was not associated with a change in the linear decline in cigarette smoking in adolescents (Dutra & Glantz 2017). Whether or not the advent of e-cigarettes has contributed to the decline in combustible tobacco use in adolescents is a continuing debate, but what is clear is that effects (if any) are subtle and do little to explain the substantial decline in adolescent smoking since e-cigarettes were introduced. Nor can they explain the dramatic decline in adolescent smoking that occurred from the late 1990s to 2010, *before* e-cigarettes became available.

Social norms and role models

Sargent et al (2009) tested the hypothesis that a decline in smoking in movies has contributed to the decline in smoking in 8th graders in the USA since 1996. The authors' ecological analysis suggests that the appearance of smoking in movies began to decline in approximately 1994, about three years before adolescent smoking began to decline in the USA. However, from 1996 a parallel trend was apparent. The authors interpreted this finding as consistent with a causal relationship between smoking in movies and uptake of adolescent smoking. Although a causal relationship is possible, an alternative (and perhaps more likely) explanation is that declines in both depictions of smoking in movies and adolescent smoking prevalence had a common cause: a decline in the social acceptability of smoking (Alamar & Glantz 2006, Hammond et al. 2006).

Osaki and colleagues examined trends in adolescent smoking and risk factors between 1996 and 2004 in Japan, based on repeat cross-sectional surveys of junior and senior high school students (aged 11-18). They found that current and daily smoking declined significantly between 2000 and 2004, as did paternal smoking and older brother smoking (though maternal smoking increased). They also found that the proportion of students reporting they had no

friends (which was a protective factor for smoking) increased over time. The contribution of these factors to the declining smoking trend was not analysed empirically, but presented as 'likely' contributors.

Determinants of adolescent drinking trends

Academic interest in the decline in youth drinking has grown rapidly over the past 3-4 years, and a growing body of empirical research has explored and tested explanatory hypotheses. Included studies are summarised in Table 9.

Table 9: Literature exploring the determinants of adolescent drinking trends

Author (date)	**Title**	**Study location** **Type of publication**	**Type of evidence presented**
Metzner & Kraus (2008)	The impact of alcopops on adolescent drinking	International Peer reviewed journal article Review	Evidence synthesis
Lintonen et al (2013)	Alcohol policy changes and trends in adolescent drinking in Finland from 1981 to 2011	Finland Peer reviewed journal article Original research	Temporal correspondence of trends
De Looze et al (2014)	Trends in alcohol-specific parenting practices and adolescent alcohol use between 2007 and 2011 in the Netherlands	Netherlands Peer reviewed journal article Original research	Changing exposure to risk/protective factors
Verhagen et al (2015)	Does a reduction in alcohol use by Dutch high school students relate to higher use of tobacco and cannabis?	Netherlands Peer reviewed journal article: Original research	Temporal correspondence of trends based on individual-level data
Bhattacharya (2016)	Youthful abandon: Why are young people drinking less?	UK NGO report	Evidence synthesis
Kelly et al (2016)	Parental supply of alcohol to Australian minors: an analysis of six nationally representative surveys spanning 15 years	Australia Peer reviewed journal article Original research	Changing exposure to risk/protective factors
Raitasalo et al (2016)	Practices in alcohol education among Finnish parents: Have there been changes between 2006 and 2012?	Finland Peer reviewed journal article Original research	Changing exposure to risk/protective factors

Author (date)	Title	Study location Type of publication	Type of evidence presented
Svensson et al (2016)	What Role Do Changes in the Demographic Composition Play in the Declining Trends in Alcohol Consumption and the Increase of Non-drinkers Among Swedish Youth?	Sweden Peer reviewed journal article Original research	Time-series modelling of association between changes in predictor and changes in outcome, at the national level
De Looze et al (2017)	Trends in adolescent alcohol use in the Netherlands, 1992-2015: Differences across sociodemographic groups and links with strict parental rule-setting	Netherlands. Peer reviewed journal article Original research	Trend analysis of contribution of predictor variables to trend, using individual level data
Lintonen & Nevalainen (2017)	Has the role of personal income in alcohol drinking among teenagers changed between 1983 and 2013?	Finland Peer reviewed journal article Original research	Trends in association between predictor and outcome, and changing exposure to predictor
Larm et al (2018)	The increased trend of non-drinking in adolescence: The role of parental monitoring and attitudes toward offspring drinking	Sweden Peer reviewed journal article Original research	Changing exposure to risk/protective factors
Pape et al (2018)	Adolescents drink less: How, who and why? A review of the recent research literature	International Peer reviewed journal article Narrative review	Evidence synthesis
Raitasalo et al (2018)	What is going on in underage drinking? Reflections on Finnish European school survey project on alcohol and other drugs data 1999–2015	Finland Peer reviewed journal article Original research	Trend analysis of contribution of predictor variables to trend, using individual level data
Toumbourou et al (2018b)	Student survey trends in reported alcohol use and influencing factors in Australia	Australia Peer reviewed journal article: Original research	Trend analysis of contribution of predictor variables to trend, using individual level data
White et al (2018)	Adolescents' alcohol use and strength of policy relating to youth access, trading hours and driving under the influence: findings from Australia	Australia Peer reviewed journal article Original research	Association between predictors and outcome, and trends in exposure to predictors

Author (date)	Title	Study location Type of publication	Type of evidence presented
Törrönen et al (2019)	Why are young people drinking less than earlier? Identifying and specifying social mechanisms with a pragmatist approach	Sweden Peer reviewed journal article Original research	Qualitative cross-sectional research

Chapter 3 showed that the average quantity of alcohol consumed in a session by adolescent drinkers increased markedly during the second half of the 1990s. Some countries also observed increasing prevalence and/or frequency of adolescent drinking in the late 1990s, before sharp falls from the early to mid-2000s. Metzner & Kraus (2008) reviewed the evidence for a causal relationship between the introduction of 'alcopops' (i.e. pre-mixed drinks, generally sweet in flavour) in the mid-1990s and increases in adolescent drinking. They found that the evidence was suggestive of a causal relationship, but the quality of the included study designs precluded a definitive conclusion (Metzner & Kraus 2008).

As summarised in two review articles (Bhattacharya 2016, Pape et al. 2018), a wide range of explanatory hypotheses for dramatic declines in adolescent drinking seen over the past 10-15 years have been put forward in the media and in academic literature. These include better enforcement of age restrictions; policy changes; reduced affordability; parenting changes; changes in the demographic composition of the adolescent population; substitution with other drugs; and changes in the perceived harmfulness and social acceptability of drinking. Other hypotheses put forward include health and fitness becoming 'cool'; changes in youth culture and preferences; slower transition into adulthood; displacement of drinking by electronic media use; and anxiety about being 'shamed' on social media. However, until very recently, few hypotheses had been empirically tested, and as Pape et al comment 'the major gap in the literature pertains to the question of *why* adolescents drink less' (Pape et al, 2018 p 11). This gap is beginning to be addressed. Recent empirical studies that test explanatory hypotheses for the decline in adolescent drinking are discussed below.

Substitution with other drugs

Verhagen et al (2015) tested and rejected the hypothesis that the decline in alcohol use was due to substitution with other drugs, finding instead that the use of alcohol, cannabis and tobacco all declined in 13-16 year old Dutch students between 2005 and 2009 (Verhagen et al. 2015). The findings of Chapter 3 also support this conclusion, showing significant declines in smoking, drinking and illicit drug use since the late 1990s or early 2000s in most high-income

countries. It is reasonable to conclude that substitution with other drugs has not been a factor in adolescent alcohol decline.

Immigration

Several authors have speculated that immigration from non-drinking (or lighter-drinking) countries, and resultant demographic and perhaps cultural shifts, might have contributed to reductions in adolescent drinking (Bhattacharya 2016, Svensson & Andersson 2016, Pape et al. 2018). For example, Bhattacharya (2016) notes that in England 11-15 year olds from ethnic minority groups are less likely to have tried alcohol than White children (e.g. 10% of Asian and 21% of Black children compared with 42% of White children) and that non-Whites account for a growing share of the population. On the other hand, he points out that declines in adolescent drinking have occurred in all ethnic groups, with the decline *greater* among White children, putting the demographic shift hypothesis into question. A Swedish study empirically tested the impact of growing ethnic diversity on adolescent drinking, and found no significant association between changes in non-drinking and changes in proportion born in Middle Eastern countries among 15-16 year olds (Svensson & Andersson 2016). The evidence, although limited, suggests demographic shifts have made little, if any, contribution to declines in adolescent drinking, and certainly cannot explain the dramatic trends since the turn of the 21st century in many high-income countries.

Affordability of alcohol

As noted in Chapter 2, a positive association between personal spending money and adolescent alcohol use is well established in the literature and declining alcohol affordability has been proposed as a contributor to recent declines in adolescent drinking since the global financial crisis (Bhattacharya 2016, Pape et al. 2018). For example, Battacharya (2016) notes that in England alcohol prices rose above wages between 2008 and 2014, and concludes that declining affordability is likely to have substantially reduced underage drinking in that country. However, although this argument may hold for young adults, adolescents often source alcohol from family and friends, and heavy drinking youth tend to drink lower priced beverages (Wall et al. 2017). So average alcohol prices may have little relevance to this population.

Furthermore, few adolescents work for wages, so their disposable income may bear little relation to average wage levels. This was borne out in a Finnish study that set out to test whether disposable income was a factor in the recent decline in alcohol use among 14 year olds (Lintonen & Nevalainen 2017). The authors found that inflation-adjusted disposable income among 14 year olds, which was principally from allowances rather than earnings,

increased two-fold in the 30 year period between 1983 and 2013, with trends apparently unaffected by the global financial crisis of 2007-08 (Lintonen & Nevalainen 2017). Their findings do not support the hypothesis that adolescents have become less able to afford alcohol. Swedish and Australian researchers have made similar observations, arguing that low cost alcohol has become more available since the turn of the century due to open borders in Sweden (Svensson & Andersson 2016) and price wars between competing supermarket chains in Australia (Livingston 2014).

In summary, there is little evidence that affordability of alcohol has decreased for adolescents. However rigorous testing of this hypothesis would include analysis of trends in both adolescent income and price of alcohol typically consumed by adolescents. To my knowledge, such studies are yet to be conducted.

Parenting

Changes in parenting have been proposed by a number of authors as a possible explanation for the decline in adolescent drinking. This hypothesis is supported by evidence of declining permissiveness towards adolescent alcohol use and/or increasing parental monitoring in many countries including the USA, New Zealand, England, Finland and the Netherlands (de Looze et al. 2014, Bhattacharya 2016, Raitasalo & Holmila 2016, Pape et al. 2018). As discussed in Chapter 2, the association between these parental factors and adolescent alcohol use is well established. Furthermore, Australian research shows the proportion of 14-17 year olds reporting parental supply of alcohol almost halved between 2004 and 2013 (Kelly et al. 2016).

Several studies empirically investigated the contribution of parenting factors to the decline in adolescent drinking (de Looze et al. 2017, Larm et al. 2018, Raitasalo et al. 2018, Toumbourou et al. 2018b). In the Netherlands, increasing prevalence of strict alcohol-specific parental rule-setting partially (but not fully) explained the decline in adolescent alcohol use between 2007 and 2015 (de Looze et al. 2017). Similarly, an Australian study found that between 1999 and 2015 a reduction in parental attitudes favourable to adolescent drinking was a significant contributor to adolescent drinking trends, as was a decline in the perceived accessibility of alcohol (Toumbourou et al. 2018b). The same study found that other family factors (e.g. conflict, parental monitoring, and residential mobility), school factors (e.g. academic failure and school attachment) and community factors (e.g. sense of safety, perception of crime/vandalism) did not contribute significantly to adolescent drinking trends. A Finnish study found that increased parental monitoring and declining ease of access to alcohol were

significant contributors to the decline in alcohol use and binge drinking in 15-16 year olds between 1999 and 2015 (Raitasalo et al. 2018).

Larm et al (2018) explored trends in both alcohol-specific parenting factors and parental monitoring, and their relationship with non-drinking in 15-16 year old Swedish adolescents between 2004 and 2015. The study found that exposure to these protective factors increased over time and associations with non-drinking were significant throughout the study period. However, the authors concluded: 'lack of interaction effects [with survey year] confirmed that neither parental monitoring nor parental attitudes toward offspring drinking were associated with the increase in the probability of non-drinking that occurred from 2003 to 2015.'

This interpretation is, in my view, incorrect. Public health action is generally directed at reducing population *exposure* to risk factors (or increasing exposure to protective factors). A change in the relationship between the exposure and the outcome over time is not expected, and is not the appropriate test of whether a predictor has contributed to a trend.[12] The appropriate test (i.e. modelling non-drinking as a function of time then adding parental factors to the model to test for attenuation, which was the approach used in the studies above by de Looze et al, Toumbourou et al and Raitasalo et al) was not applied by Larm et al. Therefore the contribution of parenting factors to adolescent drinking trends in Sweden remains uncertain.

Emerging qualitative research supports the hypothesis that parental disapproval of adolescent drinking, and closer parent-adolescent relationships may have contributed to the decline in youth drinking. For example, a Swedish study of 15-19 year olds' attitudes, habits and concerns highlighted both parental expectations that their offspring would not drink (or would do so within strict limits) and young people's perceptions that such expectations were reasonable (Törrönen et al. 2019). Other key themes were competing activities, in particular sport and academic goals, which were perceived as incompatible with heavy drinking; concerns amongst girls about the social risks of intoxication (e.g. the sharing of embarrassing or unflattering photographs on social media), and personal safety concerns (e.g. sexual assault); and the perception that drinking (along with smoking) is no longer cool. Importantly, the authors observe that drinking appears to have become less central to youth culture in general and the performance of masculinity in particular:

[12] For example an increase in seatbelt use has reduced road fatalities not because the relationship between seatbelt wearing and crash fatality has changed over time, but because the proportion of the population wearing seatbelts has dramatically increased.

> *We propose that the cultural position of drinking may have changed among young people so that drinking has lost its unquestioned symbolic power as a cool activity and rite of passage signalling entry into adulthood (Törrönen et al, 2019, p19).*

Displacement by digital media

Törrönen et al (2019) posit the rise of digital media as central to this change in youth culture, based on their qualitative findings. The hypothesis that digital media has displaced drinking was one of the most widely discussed hypotheses for the decline in adolescent drinking (Bhattacharya 2016, de Looze et al. 2017, Pape et al. 2018, Törrönen et al. 2019). None of the included studies tested this hypothesis using quantitative methods, but two reviews drew on existing evidence to appraise its plausibility (Bhattacharya 2016, Pape et al. 2018). Both noted a body of evidence showing a *positive* relationship between electronic media use and alcohol use, both in cross-sectional and longitudinal studies, and concluded that evidence to support the digital media displacement hypothesis is lacking. However these findings do not exclude the possibility that the advent of online gaming, social media etc. has changed the signifiers of status and popularity among young people, making alcohol less central to youth culture.

Policy interventions

Based on temporal correspondence, several authors suggested that policy changes or stricter enforcement of existing age restrictions may have contributed to declining adolescent drinking either directly or via the behaviour of parents and other adults (de Looze et al. 2014, Bhattacharya 2016, Pape et al. 2018, Toumbourou et al. 2018a, White et al. 2018). Examples include improved enforcement of age restrictions for alcohol purchase in the UK (Bhattacharya 2016); a 2009 alcopops tax in Australia (White et al. 2018); and a campaign aimed at parents discouraging them from supplying alcohol to adolescents aged under 16 in the Netherlands (de Looze et al. 2014). On the other hand, several authors noted that adolescent alcohol use also declined strongly in countries that had *not* introduced restrictive policy measures, and even in those where significant liberalisation had occurred in recent years, such as Finland and Sweden (Lintonen et al. 2013, Svensson & Andersson 2016, Pape et al. 2018).

The only study to rigorously test the impact of stronger alcohol policy on adolescent drinking was conducted by White et al in Australia (White et al. 2018). They investigated strength of policies in three domains (youth access, trading hours and drink driving) on past month alcohol use and past week binge drinking in 12-17 year olds in four capital cities from 2002 to 2011. After adjusting for potential confounders (exposure to alcohol and anti-alcohol

advertising, alcohol outlet density, alcohol price change, negatively framed newspaper articles about alcohol, adult drinking prevalence, student demographic characteristics, and other policy domains) they found that stronger trading hours policies and youth access policies were independently associated with reduced adolescent drinking prevalence and binge drinking respectively. Importantly, the authors noted that 'as most adolescents do not purchase their own alcohol or drink on licensed premises, the trading hours policies are unlikely to influence adolescents' alcohol use directly' (White et al. 2018 p 1038). Rather, they asserted that intensive public debate about the need to reduce alcohol-related violence by reducing trading hours (prior to the implementation of these policies) may have reduced social acceptability of alcohol use among adolescents, and thus influenced youth drinking indirectly.

Interestingly, White et al (2018) found that adolescent exposure to alcohol advertising on television fell significantly over the study period, potentially contributing to the decline in adolescent drinking. They also found that the proportion of newspaper articles that framed alcohol use in a negative light increased significantly, and that disapproving news coverage had a protective effect against adolescent drinking after adjustment. Whether other countries have also seen a change in the tone of media coverage about alcohol since the turn of the century, and/or a change in adolescents' exposure to alcohol advertising is an area for further research.

Declining smoking

Both de Looze (2017) and Toumbourou (2018) raise the possibility that successful tobacco control measures and declining smoking may have contributed to the decline in youth drinking. In the de Looze paper this assertion was based on the observation that alcohol use and tobacco use often co-occur in young people, while Toumbourou et al invoke the gateway hypothesis, namely 'that preventing adolescent involvement in one form of substance use could lead to reduced involvement in other forms of substance use' (p 7).

Determinants of declining illicit drug use

All of the identified publications aimed at explaining the decline in illicit drug use in adolescents focused on cannabis use, and the majority were US studies; one was set in Norway and one had an international focus. The included studies are summarised in Table 10.

Table 10: Literature exploring the determinants of adolescent cannabis trends

Author (date)	Title	Study location Type of publication	Type of evidence presented
Choo et al (2014)	The impact of state medical cannabis legislation on adolescent cannabis use	USA Peer reviewed journal article Original research	State-level comparison of trends in exposed and non-exposed states
Miech et al (2015)	Trends in use of cannabis and attitudes toward cannabis among youth before and after decriminalization: the case of California 2007-2013	USA Peer reviewed journal article Original research	State-level comparison of trends in exposed and non-exposed states
Fleming et al (2016)	Examination of the divergence in trends for adolescent cannabis use and cannabis-specific risk factors in Washington State	USA Peer reviewed journal article Original research	Trend analysis, modelling the contribution of predictor variables to the trend
Grucza et al (2016)	Declining Prevalence of Cannabis Use Disorders Among Adolescents in the United States, 2002 to 2013	USA Peer reviewed journal article Original research	Trends in exposure to risk/protective factors Trend analysis, modelling the contribution of predictor variables to the trend
Burdzovic et al (2017)	Ready, willing, and able: the role of cannabis use opportunities in understanding adolescent cannabis use	Norway Peer reviewed journal article Original research	Trends in exposure to risk factors Cannabis trends, stratified by exposure
Cerda et al (2017)	Association of State Recreational Cannabis Laws With Adolescent Cannabis Use	USA Peer reviewed journal article Original research	State-level comparison of trends in exposed and non-exposed states
Miech et al (2017)	Prevalence and Attitudes Regarding Cannabis Use Among Adolescents Over the Past Decade	USA Peer reviewed journal article Original research	Trend analysis, modelling the contribution of predictor variables to the trend
Grucza et al (2018)	Cannabis decriminalization: A study of recent policy change in five U.S. states	USA Peer reviewed journal article Original research	State-level comparison of trends in exposed and non-exposed states

Legal status of cannabis use

Considerable recent US research has focused on the impact of decriminalisation/legalisation on cannabis use among adolescents. At the state level, two studies found that adolescent cannabis use increased in California and Washington respectively following decriminalisation. But there was no significant increase in adolescent cannabis use after decriminalisation in Massachusetts, Connecticut, Rhode Island, Vermont, Maryland, or Colorado following legalisation (Miech et al. 2015, Cerda et al. 2017, Grucza et al. 2018b). At the national level, surveys suggest adolescent cannabis use has not increased markedly in recent years, despite adolescent attitudes becoming more accepting and the perception of the harmfulness of cannabis decreasing (Choo et al. 2014, Fleming et al. 2016, Miech et al. 2017). This is a surprising finding since attitudes (e.g. perceived harmfulness and disapproval) have, until 2005, been strongly predictive of adolescent cannabis use trends at the population level (Miech, 2017).

Smoking and drinking trends, and opportunities for cannabis use

Fleming et al (2016) and Miech et al (2017) tested two hypotheses that might account for the recent divergence between cannabis attitudes and behaviour: i) that the relationship between perceived harmfulness and cannabis use had weakened over time, and ii) that declines in alcohol and tobacco use account for the lack of increase in cannabis use. Both studies reached the same conclusions: the relationship between cannabis attitudes and use remained strong over time (if anything, it strengthened) and the lack of resultant increase in cannabis use was accounted for by the decline in tobacco and alcohol use (Fleming et al. 2016, Miech et al. 2017). Interestingly, Miech et al found that when the sample was divided into tobacco smokers and non-smokers, cannabis use increased over the study period in *both* groups. However it did not increase in the sample as a whole because the proportion in the smoking group (who were much more likely to be cannabis users) decreased substantially over time.

Fleming et al (2016) concluded: 'Through gateway or complementary processes, decreases in alcohol and cigarette use may have directly dampened a potential increase in adolescent marijuana use' (p 7). In other words, because fewer adolescents smoke and drink, then a smaller proportion are exposed to drug-using peer networks or neural 'priming' for substance use – the causal pathways posited to underlie the gateway effect (Kandel & Kandel 2015, Miech et al. 2017). Alternatively, since cannabis is customarily used in social contexts in which smoking and drinking also take place, fewer smoking and drinking occasions have resulted in fewer opportunities to use cannabis. Although Miech et al (2017) and Fleming et al (2016)

both suggest that a causal relationship is plausible between tobacco/alcohol trends and cannabis trends, they note that their findings are also consistent with the 'common liability' perspective. That is, there may be common factors putting downward pressure on substance use in general.

A Norwegian study also explored the apparent paradox that increasingly favourable attitudes towards cannabis have *not* led to an increase in cannabis use in that country. The authors found that a decline in the proportion of 16 year olds who had a realistic opportunity to try cannabis explained the mystery. Among those who had an opportunity to use cannabis, the proportion who willingly took the opportunity increased over time. However, the proportion who had an opportunity to try cannabis decreased and, as a result, the population prevalence of cannabis use remained constant despite increasing social acceptance of cannabis, and a decline in perceived harmfulness (Burdzovic & Bretteville-Jensen 2017). These findings fit with the complementary processes outlined above i.e. fewer drinking and smoking occasions result in fewer opportunities to use cannabis. They also fit with the 'common liability' hypothesis that adolescents are going out less frequently, and therefore opportunities for substance use of any kind have decreased over time.

Changing social environment

A US study found that exposure to several known risk and protective factors for adolescent cannabis use changed significantly between 2002 and 2013, in a direction consistent with declining cannabis use (Grucza et al. 2016). The risk factors for which exposure declined over time were: arguing with parents, conduct problems, and parental drug attitudes favourable to drug use. The protective factors for which exposure increased were: attitudes toward school, activity participation, parental monitoring, and parental affirmation. Trend analysis showed that, of these seven factors, conduct problems was the only one that significantly attenuated the trend for cannabis use disorder in 12-17 year olds, when added to the model. The authors interpreted these findings as suggestive of common liability and concluded:

> *[O]ur study suggests that there are one or more environmental factors – yet to be identified – that may be changing over time in a manner that leads to both lower risk for marijuana use disorders and for other behavioral problems' (Grucza et al, 2016 p 492).*

The study rules out the other six risk/protective variables that were tested.

Determinants of changes in adolescent sexual behaviour

As discussed in the previous chapter, fewer adolescents in New Zealand, England and the USA are becoming sexually active at less than 16 years of age, and teenage pregnancy rates have fallen substantially since the turn of the century in all the countries of interest. However condom use among adolescents under 16 years of age has declined.

Studies aimed at explaining population-level trends in adolescent sexual behaviour and fertility are summarised in Table 11. Almost all are US studies focused on causes of the decline in teenage pregnancy. Only two studies empirically investigated the causes of the decline in underage sex (Manlove et al. 2009, Driscoll & Abma 2015), however this was a topic discussed by several authors with reference to existing literature.

Table 11: Literature exploring determinants of trends in adolescent sexual behaviour

Author (date)	Title	Study location Type of publication	Type of evidence presented
Santelli et al (2007)	Explaining recent declines in adolescent pregnancy in the United States: the contribution of abstinence and improved contraceptive use	USA Peer reviewed journal article Original research	Modelling expected contribution of improved contraception to trends, based on method-specific contraceptive failure rates and survey data on contraceptive use
Manlove et al (2009)	Trends in sexual experience, contraceptive use, and teenage childbearing: 1992-2002	USA Peer reviewed journal article Original research	Changing exposure to risk factors
Santelli et al (2009)	Changing behavioral risk for pregnancy among high school students in the United States, 1991-2007	USA Peer reviewed journal article Original research	Modelling expected contribution of improved contraception to trends, based on method-specific contraceptive failure rates and survey data on contraceptive use
Santelli & Melnikas (2010)	Teen Fertility in Transition: Recent and Historic Trends in the United States	USA Peer reviewed journal article Review	Evidence synthesis
Yang & Gaydos	Reasons for and challenges of	USA	State-level comparison

Author (date)	Title	Study location Type of publication	Type of evidence presented
(2010)	recent increases in teen birth rates: a study of family planning service policies and demographic changes at the state level	Peer reviewed journal article Original research	of trends in exposed and non-exposed states
Boonstra (2014)	What Is Behind the Declines in Teen Pregnancy Rates?	USA Peer reviewed journal article Review	Evidence synthesis
Driscoll & Abma (2015)	Changing Sociodemographic Factors and Teen Fertility: 1991-2009	USA Peer reviewed journal article Original research	Changing exposure to risk factors
Girma & Paton (2015)	Is education the best contraception: the case of teenage pregnancy in England?	England Peer reviewed journal article, Original research	Comparison of regional of trends in exposed regions with national average
Kearney & Levine (2015)	Investigating recent trends in the U.S. teen birth rate	USA Peer reviewed journal article Original research	State-level comparison of trends in exposed and non-exposed states
Lindberg (2016)	Understanding the Decline in Adolescent Fertility in the United States, 2007-2012	USA Peer reviewed journal article Original research	Modelling expected contribution of improved contraception to trends, based on method-specific contraceptive failure rates and survey data on contraceptive use
Santelli et al (2017)	Global Trends in Adolescent Fertility, 1990-2012, in Relation to National Wealth, Income Inequalities, and Educational Expenditures	International Peer reviewed journal article Original research	Ecological association between trends in outcome and trends in exposure to national-level risk and protective factors

Determinants of declining adolescent sexual activity

Manlove et al (2009) and Driscoll et al (2015) provide empirical evidence that exposure to known risk factors for underage and unprotected sex declined from the early to mid-1990s in

the USA. For example, the proportion of adolescents born to teenage mothers has decreased in successive cohorts, and parental (in particular, maternal) education levels have increased (Manlove et al. 2009, Driscoll & Abma 2015). Furthermore, the proportion of adolescents with an older sexual partner – a risk factor for early sexual debut – declined significantly between 1992 and 2002 among boys and girls, but the decline among girls was not statistically significant (Manlove et al. 2009). Although changes in exposure to these risk factors suggests they may have contributed to declining adolescent sexual activity, neither of these studies tested these hypothesised factors through trend analysis.

Two of the authors cited in the first section of this chapter, on the determinants of declining risk behaviour as a whole, also had comments on why young people may be starting their sex lives later. Harris (2017) argues that the decline in unsupervised free time is likely to be a key factor in declining adolescent sexual activity: 'At a basic level, sex at its best is unstructured play with friends, a category of experience that … has been decreasing for American adolescents' (p 193). He also speculates that declining libido due to increasing anxiety and depression (or medication to treat these conditions) may be a factor.

Importantly, Harris points out that much early sexual activity may be unwanted or coercive, and decreasing sexual victimisation may be a contributor to declines in early sexual debut. He cites evidence from several US sources (including crime victimisation surveys, which do not rely on police reports) showing that child sexual abuse has declined substantially since the early 1990s, and that sexual assault of teenagers has decreased markedly since the late 1990s (Harris 2017). The decline in sexual victimisation of young people in the USA has also been reported elsewhere (Finkelhor et al. 2014).

Twenge (2017) suggests that the internet may have influenced sexual behaviour: a) by reducing face to face contact between peers and thereby reducing opportunities for sex, and b) by opening new 'safer' avenues for sexual expression and exploration e.g. via 'sexting' and viewing of pornography. While Twenge supports the first hypothesis with trend data showing a decline in face to face socialising, the second is more speculative. It does not square with a body of evidence that indicates pornography viewing and sexual behaviour are *positively* correlated (Owens et al. 2012) as are online and offline sexual risk taking in adolescents (Baumgartner et al. 2012). Rather than delaying sexual debut, there is consistent evidence that exposure to online pornography *accelerates* sexual debut (Owens et al. 2012).

Boonstra (2014), citing a UNESCO review, states that comprehensive and high-quality sex education can influence adolescents' sexual behaviour. Yet whether access to such sex education has increased in the USA (or elsewhere) in recent years is not reported. Given the US emphasis on 'abstinence only' sex education – which has been shown to be ineffective (Kirby 1997, Santelli et al. 2007) – improved access to quality sex education over time is by no means a given. Indeed, the proportion of US adolescents who reported receiving formal instruction about contraception *declined* between 2006 and 2012 (Lindberg et al, 2016).

Boonstra et al (2014) raise the possibility that, since internet access became widespread in the late 1990s/early 2000s, the worldwide web may now be filling the sex education information gap for adolescents. The idea that internet access may have improved teens' access to contraception and sexuality information (and thereby led to better choices) has face validity, but none of the included publications provided empirical support for this hypothesis.

In summary, there is a wide range of contextual factors that may have contributed to declining sexual activity in adolescents, and later sexual debut. While there is supporting evidence for some hypothesised factors (e.g. a decreasing proportion born to a teen mother, increasing parental education, decreasing unsupervised time), their contribution to the decline in adolescent sexual activity has not been rigorously tested and remains uncertain.

Determinants of declining adolescent pregnancy rates

Adolescent sexual activity

Increasing age of sexual debut and decreasing sexual activity among 15-17 year olds have contributed to declining adolescent pregnancy rates. However, there is agreement that increasing use and effectiveness of contraception has been the main factor driving the long-term decline in adolescent fertility in the USA (Santelli et al. 2007, Santelli et al. 2009, Santelli & Melnikas 2010, Boonstra 2014, Lindberg et al. 2016). For example, Santelli et al (2007) estimate that between 1995 and 2002 about a quarter of the decline in 15-17 year old fertility was due to delayed or less frequent sexual activity, and three quarters was due to increased or more effective contraception (Santelli et al. 2007). The relative contribution of less sex versus better contraception to teen pregnancy decline has not been tested in other countries, and the generalisability of US findings is unknown. Key themes in contextual factors contributing to declining adolescent pregnancy are discussed below.

Access to contraception and sexual health services

In New Zealand, there is evidence that better availability and quality of school-based health services is associated with fewer pregnancies at the school level (Denny et al. 2012, Lewycka et al. 2018). Lewycka et al report that youth health quality standards were introduced in 2002 and further refined in 2006 and school-based health services were expanded during this period (Lewycka et al. 2018). Thus it is plausible that increasing access to contraception and sexual health services via school-based clinics may have contributed to a decline in adolescent pregnancy in New Zealand in the early 21st century.

There is wide agreement among US researchers that state-level changes that expanded eligibility for family planning services covered by Medicaid to women who would not otherwise have been eligible played a significant role in reducing teen pregnancy and birth rates from the early 1990s (Kearney & Levine 2009, Santelli & Melnikas 2010, Yang & Gaydos 2010, Boonstra 2014). Empirical studies show that 'Medicaid family planning waivers' (so called because states must apply for a waiver of usual Medicaid eligibility rules in order to provide these services) substantially increased the number of women receiving family planning services via Medicaid (Kearney & Levine, 2009). Quasi-experimental and econometric studies comparing 'intervention' and 'control' states found that Medicaid waivers reduced birth rates in all age groups, and teenage births in particular (Kearney & Levine 2009, Yang & Gaydos 2010). It is presumed that these policy changes influenced teen pregnancies via improved contraception. However this link in the causal chain has not been empirically verified, as far as I am aware. As noted previously the majority of teen pregnancies are to women aged 18 or older, and it is unclear to what extent these policy changes increased access to contraception and sexual health services for school-aged adolescents, in particular those aged less than 16.

Teenagers' access to effective contraceptives in the USA is also likely to have been improved by changes to medical practices since the early 2000s e.g. recognition of the IUD as a 'first line' contraception option for adolescents within medical guidelines, and relaxation of the requirement for a pelvic exam before prescribing the oral contraceptive pill (Boonstra 2014). Such changes may also be relevant to countries outside the USA.

As noted above, there are mixed views about the impact of access to new reproductive technologies (e.g. contraceptive implants, new-generation IUDs and emergency contraceptives or 'the morning after pill') on teen pregnancy rates. Girma & Paton note that LARCs (long acting reversible contraceptives) have been actively promoted in some parts of

England, but found 'the magnitude of the effects is too small and uncertain to satisfactorily explain much of the overall decline in teenage pregnancy' (2015, p 7).

Sex education

Although evidence reviews have concluded that comprehensive sex education can successfully influence contraceptive use (Boonstra 2014), 'abstinence only' sex education has remained dominant in the USA, and is associated with higher rates of teen pregnancy at the state level (Yang & Gaydos 2010). Researchers generally agree that improved sex education in schools has played little, if any, role in the decline in teen pregnancy in the USA since 2000 (Boonstra 2014, Kearney & Levine 2015, Lindberg et al. 2016). This is a perception backed up by empirical research (Kearney & Levine 2015). However, some researchers believe that health education and policy changes implemented in response to the HIV/AIDs epidemic in the 1980s and 1990s influenced adolescent behaviour either directly (e.g. by increasing awareness about condom use and access to condoms) or indirectly (e.g. via culture change in relation to sexuality). While this may be plausible in the USA, where teen pregnancy began its decline soon after HIV/AIDs action was implemented, it is notable that many other developed countries including New Zealand saw a *rise* in teen pregnancy during the very period when HIV/AIDs awareness in the general population was at its most intense (i.e. late 1980s and early 1990s).

Family environment

As discussed above, Manlove et al (2009) and Driscoll et al (2015) provide empirical evidence that exposure to key risk factors for teen pregnancy in the family environment has declined since the early to mid-1990s in the US. For example, the proportion of teens born to teenage mothers or born to mothers who did not complete high school has decreased in successive cohorts (Manlove et al. 2009, Driscoll & Abma 2015), while the relationship between these factors and teen birth have remained similar over time (Driscoll & Abma 2015).

Changing demographic structure of the population

Teen pregnancy and birth rates differ markedly by age and ethnicity, and several researchers have explored the impact of changing demographic makeup on teen pregnancy rates. For example, in the USA the Hispanic population (which has a higher teen birth rate than White or African American populations) has increased markedly in the decades since 1991. Therefore, based on demographic changes alone, we would expect to see a substantial *increase* in teen births (Boonstra 2014, Kearney & Levine 2015) rather than the decline that has actually occurred. Yang & Gaydos (2010) argue that the rise in teen pregnancies between 2005 and

2007 in the US can largely be attributed to the rising Hispanic population, but this conclusion is difficult to square with the fact that the Hispanic population has risen steadily over the decades that teen pregnancy has been consistently falling.

Most researchers agree that changes in the ethnic composition in the USA do not account for the long term decline in adolescent births (Santelli & Melnikas 2010, Boonstra 2014, Kearney & Levine 2015). In the UK however, Girma & Paton (2015) concluded that increases in the non-White population are associated with statistically significant declines in teen pregnancy, possibly reflecting more conservative attitudes to adolescent sexuality in new immigrants or a higher value placed on education.

Kearny & Levine (2015) demonstrate that, since 18-19 year old birth rates are high compared to those of younger teens, a short term 'blip' in the proportion of the US population aged 18-19 between 1986 and 1990 and subsequent return to 'normal' between 1990 and 1992 can explain most of the rise and subsequent fall in teen pregnancy rates in the late 1980s and early 1990s.

Labour market/economy

Findings are mixed with regard to the influence of economic factors on adolescent childbearing. Globally, economic development (rising national wealth and gross domestic product per capita) is associated with a demographic shift towards smaller family size, later childbearing and a reduction in adolescent fertility, as demonstrated empirically by Santelli et al (2017). However in high-income countries that went through this demographic transition many decades ago, the impact of ongoing economic and labour market fluctuations is less clear. Kearney & Levine's (2015) econometric analysis found that higher unemployment rates were associated with lower teen birth rates. They note that this is consistent with prior US findings that fertility tends to decline in times of economic hardship, presumably because families cannot afford time off work or another mouth to feed. They estimate that the rise in unemployment between 2007 and 2010 accounted for 16% of the decline in teen pregnancy over this period, but conclude that unemployment changes had a much more modest influence over the long term (i.e. 1991-2010).

In England, Girma & Paton (2015) reached the opposite conclusion, finding a *positive* relationship between unemployment and teen pregnancy between 2004 and 2012. This result confirmed their hypothesis, which was based on the assumption that the opportunity cost of bearing a child is lower in times of limited labour market opportunities. These contrasting

findings may reflect differences between the USA and England in social welfare provisions for teen mothers, or alternatively may be due to methodological limitations or bias. As Boonstra points out, while the US economy has waxed and waned since 1991, the teen pregnancy rate has declined steadily (aside from a brief reversal in the mid-2000s) suggesting that the national economy is not a major influence.

Educational participation and achievement

Globally there is a strong association between increasing girls' educational participation and reducing adolescent childbearing (Santelli et al. 2017). This has been demonstrated not only in developing countries but in England, where Girma and Paton (2015) found that the most significant factor in the decline in teen pregnancy between 2004 and 2012 was an increase in the proportion of 16 and 17 year olds in full time education (from 20% to almost 80%) and an increase in educational achievement. They estimated that a 10% increase in achievement of GCSE implies a reduction in the teen pregnancy rate of about 8%, and note that the number in England achieving five good GCSEs has increased by about 50% since 2004. Although US researchers acknowledge that academic success and educational opportunities are protective against teen pregnancy (Santelli & Melnikas 2010, Boonstra 2014), an increase in academic participation and achievement has not been explored as an explanatory factor for declining pregnancy in the US, or the other countries of interest.

In summary, improved access to contraception appears to have played an important role in declining adolescent pregnancy rates (at least in the US), while improved school-based sex education is an unlikely explanation at the national level. In England, increased participation in full time education appears to have been the primary driver of declining teen birth rates, which is consistent with global findings that improved educational opportunities for girls are strongly linked with declining adolescent fertility. There were mixed findings as to the role of demographic shifts and economic factors. Most of these studies focused on teen births (i.e. to mothers aged 15-19 years) as the outcome of interest, and did not provide separate analysis for adolescents (under 18 years of age) who are a minority among teenage mothers. Therefore the applicability of findings to this younger subgroup is uncertain. Many studies used ecological approaches, which have inherent limitations.

Summary of literature review findings

Many hypothesised causal factors have been put forward to explain the decline in adolescent risk behaviour, but few have been tested. The findings of the empirical studies that *have* tested hypothesised contributors to declines in adolescent risk behaviour using rigorous

methods are summarised in Table 12. Sexual behaviour is not included in the table since there have been no studies (as far as I am aware) that have tested hypotheses for the decline in adolescent sexual activity using robust methods.

Table 12: Summary of hypothesised determinants of adolescent risk behaviour trends rigorously tested in the literature

Risk behaviour	Supported	Refuted	Mixed evidence
Risk behaviours in multiple domains	Declining face to face contact with friends in the evening (de Looze 2019) Decline in a latent 'externalising-like' trait (Grucza 2017)	Rising electronic media communication (de Looze 2019)	
Smoking	Rising tobacco prices (Pampel & Aguilar 2008) Declining cannabis use (Pampel & Aguilar 2008) Strength of tobacco control policies (White 2011)	Mobile phone ownership/use (Koivusilta 2003, Peretti-Watal 2009, Osaki 2012) Changing exposure to risk factors: single-parent family, low parental education, academic failure, having a part time job, low religiosity, frequently going out at night (Pampel & Aguilar 2008) Adult smoking prevalence (Pampel & Aguilar 2008) Social strain/youth unemployment (Pampel & Aguilar 2008)	Availability of e-cigarettes (Friedman 2015, Dutra 2017, Pesko 2016) Anti-tobacco advertising (Pampel & Aguilar 2008; White 2015)
Alcohol use	Alcohol-specific parenting attitudes and practices (de Looze 2014, Kelly 2016, Raitasalo 2016, de Looze 2017, Toumbourou 2018)	Substitution with other drugs (Verhagen et al 2015) Immigration/ demographic shifts (Svensson et al, 2016)	Parental monitoring (Toumbouro 2018b, Raitasalo 2018, Larm 2018)

Risk behaviour	Supported	Refuted	Mixed evidence
	Decline in perceived ease of access to alcohol (Toumborou 2018, Raitasalo 2018)	Decreasing affordability (Lintonen 2017) School factors (Toumbourou 2018) Neighbourhood factors (Toumbourou 2018b)	
Cannabis use	Declining adolescent smoking and alcohol use (Fleming 2016, Miech 2017) Fewer opportunities to try cannabis (Burdzovic 2017)	Decriminalisation/ legalisation of cannabis (Choo 2014, Grucza 2018) Decreasing exposure to: arguing with parents and parental drug attitudes favourable to drug use (Grucza 2016) Increasing exposure to: positive attitudes toward school, activity participation, parental monitoring, and parental affirmation (Grucza 2016)	

Some hypothesised determinants known to influence a range of risk behaviours – e.g. parental monitoring, family attachment, and unstructured time with peers – are supported by evidence of changing exposure (in the appropriate direction) over the study period. However there is mixed evidence about whether increasing parental monitoring has contributed to trends, and other common determinants are yet to be tested. A decline in face to face contact with friends in the evening is the only common determinant to have been rigorously tested, and found to have a country-level association with declining substance use internationally (de Looze et al. 2019).

Displacement of risk behaviour by digital media (i.e. mobile phone use, social media, gaming and screen-based entertainment) is often proposed as the main driver of the decline in

adolescent behaviour, yet this hypothesis has no empirical support despite considerable investigation. At the individual level, digital media use is a *risk* factor (not a protective factor) for risk behaviours (Koivusilta et al. 2003, Peretti-Watel et al. 2009, Osaki et al. 2012, de Looze et al. 2019). At the country level, trends in electronic media communication are not associated with trends in substance use (de Looze et al. 2019). However, these findings do not preclude the possibility that the digital revolution has influenced youth culture and the social meaning young people attach to risk behaviours.

Adolescent alcohol decline is the most extensively researched, and several hypothesised contributors have been rigorously tested. There is consistent evidence from several countries that alcohol-specific parenting factors (e.g. less permissive attitudes and stricter rule setting around alcohol use) have played an important role, along with a decline in the perceived availability of alcohol.

Discussion

Both the quantity and quality of evidence is limited, but it is possible to draw some conclusions from the available evidence. Firstly, there is no empirical evidence to support the hypothesis that mobile phones or digital media have displaced risk behaviour in terms of time use, and there is a growing body of evidence that refutes this hypothesis. Based on evidence to date, it appears that risk behaviour has declined *in spite of*, not because of the fact that young people are spending more time online. However the possible impact of the digital revolution on the cultural position and social meaning of risk behaviours remains to be fully explored.

Secondly, there is consistent evidence that parental factors, in particular alcohol-specific parental attitudes and practices, are an important contributor to the decline in adolescent drinking. There is mixed evidence about whether general parenting factors (e.g. parental monitoring, family attachment) have contributed. Previous longitudinal research suggests that alcohol-specific parenting is more influential than general parenting for preventing alcohol use (Van Zundert et al. 2006). Indeed, there is evidence that low alcohol use predicts family attachment more than vice versa (Van Zundert et al. 2006), so improvements in parent-adolescent relationships in successive cohorts may be the *result* of declining risk behaviour, not the cause. It is possible that findings relating to alcohol-specific parenting factors may be transferable to other risk behaviours. In particular, it seems plausible that smoking-related parental rules and expectations may also have become less permissive over time, contributing

to the decline in adolescent smoking. However, as far as I know, this hypothesis has not yet been empirically tested.

Perceived ease of access to alcohol was found to be a factor in two studies, with evidence from Australia that reduced parental supply of alcohol may have contributed to declining ease of access. Whether these findings are generalisable to other countries, or transferable to other substances, are areas for future research. A further question is *why* perceived access has decreased. Has declining parental supply been the main contributor, or is there evidence that policy changes or stricter enforcement have played a role?

There is a lack of consensus about the extent to which declining risk behaviours are the result of policies and interventions. Tobacco control has steadily tightened over the study period in high-income countries, with countries that have been international leaders in tobacco control (e.g. Australia) showing some of the earliest and steepest declines in adolescent smoking internationally. Therefore tobacco control efforts seem highly likely to have played a role in the decline in youth smoking. However, evidence of direct policy effects on adolescent smoking prevalence at the population level is rather scant, and there was no obvious policy trigger for the almost simultaneous decline in adolescent smoking across the countries of interest from the late 1990s.

Alcohol control policy changes have generally been weak where they have been implemented at all, and in some countries (notably Finland and Sweden) declining adolescent drinking has coincided with *liberalisation* of alcohol policy. Could it be that public concern and policy debate may be more important than actual policy implementation when it comes to influencing parents' and adolescents' behaviour and attitudes toward alcohol?

It is interesting to note that (with the exception of the digital media displacement hypothesis) few common themes appeared across these different bodies of research. Publications addressing risk behaviours as a whole (e.g. Twenge, Arnett, Harris) tended to assume a unitary trend and paid little attention to behaviour-specific drivers. Conversely, 'shared' risk/protective factors are rarely mentioned (and even more rarely tested) in relation to specific risk behaviours. For example, a decline in unsupervised time, noted by Twenge and Harris, is a plausible contributor to declining adolescent risk behaviour in each domain, yet this was not picked up as a possible driver of declining tobacco use or drug use.

Only a small proportion of studies considered relationships *between* risk behaviours. Toumborou et al (2018a, 2018b) and de Looze (2017) speculated that declining tobacco use

may have led to declines in alcohol and cannabis use among young people, but did not test this possibility. Pampel and Aguilar (2008) demonstrated that US trends in tobacco and cannabis were related, but considered that this was due to common liability rather than a causal relationship.

More recently, two US studies concluded that, due to attitude change, adolescent cannabis use would have increased substantially in that country from 2005/2006 had tobacco smoking and alcohol use not declined (Fleming et al. 2016, Miech et al. 2017). Authors of both studies considered that a causal relationship was plausible, but did not discount common liability as an explanation for the observed findings. Surprisingly, a causal relationship between declining alcohol use and declines in other risk behaviours does not appear to have been considered by any of the authors. Given the known association between binge drinking and impulsive behaviour and the fact that drinking occasions are likely to provide opportunities for smoking, cannabis use and meeting sexual partners, a causal relationship seems very plausible.

The complexity of influences on adolescent behaviour (with bi-directional influences and feedback loops) makes the isolation of 'causes' methodologically challenging. Yet the literature is fertile with promising explanations worthy of further investigation. The following chapters provide such investigation, exploring the possible role of tobacco-specific factors (Chapter 5), common underlying factors in home, school and leisure environments (Chapter 6), age of initiation (Chapter 7), adolescent attitudes to substance use and parental modelling (Chapter 7), and the influences of risk behaviours on one another (Chapter 8). These studies comprise the first empirical examination of the drivers of declining risk behaviour in the New Zealand context, and as such make an important contribution to an under-researched phenomenon.

CHAPTER 5. TOBACCO-SPECIFIC DRIVERS

Introduction

In New Zealand regular smoking (defined as at least monthly) among Year 10 students (14-15 years) declined from a peak of 29% in 1999 to 5% in 2015, with decreases across all main ethnic groups, and a convergence between boys and girls over the period (ASH 2018a). Over the same period, the proportion who had never smoked (i.e. not even a few puffs) rose from 32% to 79% (ASH 2018a). However, as in other countries (Green et al. 2016), ethnic and socio-economic disparities remain pronounced. For example Māori smoking prevalence in this age group was 11% in 2015 compared to 4% among non-Māori (ASH 2018b).

The reasons for this remarkable decline in adolescent smoking have not been empirically investigated and hence are uncertain. As noted in Chapter 2, parental, sibling and peer smoking are all consistent predictors of adolescent smoking, as is exposure to smoking in the home. Could declines in these important predictors explain the decline in adolescent smoking? It is certainly plausible that exposure to these predictors may have declined since 2000 due to decreasing adult smoking rates (Ministry of Health 2017) and denormalisation of indoor smoking (Edwards et al. 2008). However, to my knowledge, the contribution of these hypothesised contributors has not been tested either in New Zealand or internationally. It is also possible that tobacco tax increases – the most consistently implemented tobacco control measure in New Zealand in recent years – have influenced adolescent smoking via increasing tobacco prices, as demonstrated in the USA by Pampel & Aguilar (2008).

The aims of this study were to test these hypotheses, and to investigate whether the factors associated with adolescent smoking and smoking decline in the general population were similar or different for Māori.

This study uses repeat cross-sectional data from the annual ASH Year 10 Snapshot Survey (2002-2015). Part 1 explores the extent to which the decline in adolescent smoking can be explained by changes over time in key individual-level predictors: smoking status of parents, older sibling(s) and best friend, and exposure to others' smoking in the home. Part 2 investigates the possible impact of regulatory changes on adolescent smoking, specifically the role of tobacco taxation.

ASH New Zealand (the data owners) provided the data to the project team comprising Prof Richard Edwards (Principal Investigator), Dr Dalice Sim (Statistician) and myself. We secured a University of Otago research grant (UORG) to support the work. I was lead author of the UORG funding application, analysis plan and resulting publications, and had substantial input into the study design and modelling approach. I also completed the descriptive analysis. Prof Edwards provided direction and oversight and Dr Sim was the consultant statistician on the project and completed the data cleaning/assembly, multivariable analysis and ecological analysis. To date, this work has resulted in several conference contributions and two publications (Ball et al. 2018a, Ball et al. 2018b). Some of the content of those publications is reproduced in this chapter.

Part 1: The role of known individual-level risk factors

Background

The aim of the first part of the study was to investigate the extent to which changes in established individual level risk factors for adolescent smoking (parental, sibling and peer smoking, and exposure to smoking in the home) explained the downward trend in adolescent smoking in New Zealand, 2002-2015.

Proximal individual level risk factors for adolescent smoking have been studied extensively. As discussed in Chapter 2, parental, sibling and peer smoking have consistently been identified as among the strongest risk factors for adolescent smoking (Tyas & Pederson 1998, Centers for Disease Control 2012). The Surgeon General's 2012 evidence review concluded that the evidence is suggestive of a causal role for peer influences, and a potential causal role for parental smoking and found that smoking by older siblings influences smoking in adolescents more consistently than does smoking by parents (Centers for Disease Control 2012). Exposure to smoking in the home, although a less studied factor, has also been shown to predict smoking in adolescents in longitudinal and cross sectional studies, independently of parental smoking status (Darling & Reeder 2003, Becklake et al. 2005, Voorhees et al. 2011, Waa et al. 2011, Wang et al. 2011). Studies suggest second hand smoke exposure may biologically predispose children to nicotine dependence (Okoli et al. 2007, Belanger et al. 2008, Brody et al. 2011, Selya et al. 2012, Schuck et al. 2013) in addition to providing pro-smoking socialisation (Waa et al. 2011).

Could declining exposure to these predictors explain the dramatic decline in adolescent smoking in New Zealand since the turn of the century? Despite extensive risk factor research,

few studies have explored how exposure to risk factors has changed over time, and none have investigated how such changes may be contributing to changes in adolescent smoking at the population level.

Research questions

The research objectives were to:

- Investigate the extent to which parental, sibling and peer smoking and exposure to smoking in the home were associated with adolescent smoking in the New Zealand setting throughout the 2002 to 2015 study period.
- Investigate the extent to which exposure to these predictors changed between 2002 and 2015, overall and by ethnicity and school decile.
- Investigate the extent to which these predictors contributed to the decline in smoking prevalence over time, for the general adolescent population and for Māori.

Methods

Survey methods – sampling and data collection

We used repeat cross-sectional data from the ASH Year 10 Snapshot Survey series, an annual school-based survey of Year 10 students (aged 14-15 years), which is administered by ASH and is part of the New Zealand Youth Tobacco Monitor. ASH provided access to individual-level data for the whole survey series to 2015. The questionnaire includes a set of 'core' questions that have remained consistent over time to enable trend monitoring, and additional questions which change from year to year. Years included in the current study were 2002-2015, since key variables of interest were unavailable prior to 2002. Furthermore, exposure to smoking in the home was not included in the questionnaire in 2002 or 2004-5, and therefore multivariable analysis includes only data from 2003 and 2006-15.

All public and private schools with Year 10 students were invited to participate in the ASH Year 10 Snapshot Survey each year. Table 13 shows the sample size and student response rate (as a proportion of the total New Zealand Year 10 population) by year. Non-response was almost entirely at the school level, with school response rates ranging from 44-67% (ASH 2014). The lower school response rate in 2015 was reportedly due to limited resources for liaising with schools that year (S Sunseri, personal communication, June 2016).

Table 13: ASH Year 10 Snapshot sample size and student response rate by year

Year	NZ Year 10 population	Valid survey responses	Valid survey responses that met all study inclusion criteria	% Year 10 population that met all study inclusion criteria
2002	58,812	29,173	28,088	50%
2003	61,028	32,705	31,377	54%
2004	62,852	31,630	30,807	46%
2005	64,619	32,561	31,833	51%
2006	63,086	32,844	31,690	52%
2007	62,012	25,978	25,109	42%
2008	61,485	30,903	29,682	50%
2009	61,355	25,757	24,755	42%
2010	61,210	32,832	31,696	54%
2011	59,562	26,856	26,028	45%
2012	59,627	31,983	30,396	43%
2013	57,929	28,340	27,014	49%
2014	59,612	31,125	29,303	47%
2015	59,528	21,567	20,443	36%
Total	**852,717**	**414,254**	**398,221**	**47%**

Following previously published ASH NZ analyses, our analysis was restricted to respondents aged 14 or 15 at the time of the survey. For consistency between descriptive and multivariable (i.e. adjusted) analyses, only respondents with complete data for all variables (smoking status, parental smoking, sibling smoking, best friend smoking, age, gender, ethnicity, school decile, and school ID, and, for 2003 and 2006-15, exposure to smoking in the home) were included in the analyses. In addition, only schools with at least 20 respondents were included so that results were based on stable estimates of smoking in each school. Table 13 shows the number of valid survey responses received based on the ASH NZ criteria for inclusion (i.e. those with complete data for age (14/15 years), sex, ethnicity and smoking status), and the number included in our study after the exclusions above, by year. After application of our additional inclusion criteria, 96% (398,221 out of 414,254) of valid responses were included.

The survey was administered earlier in the year in 2011 and subsequently, meaning respondents were 2-3 months younger on average in 2011 and subsequent years, than in previous years. Excluding the timing of fieldwork and changes to non-core questions, there has been consistency in survey instruments, survey administration and data management across the included years.

The survey is completed in class time under the supervision of teaching staff. Individual students may choose not to participate. To protect the confidentiality of students' responses, identifying information is not collected, and teachers are requested not to check the completed surveys. Completed surveys are returned to ASH, which oversees data entry, cleaning and coding.

The survey was approved, as a component of the New Zealand Youth Tobacco Monitor, by the Ministry of Health Multiregional Health and Disability Ethics Committee in 2007. Further details on survey methodology are available elsewhere (ASH 2014).

Variables

Regular smoking (defined as monthly or more often) was the primary outcome variable, since it is predictive of future daily smoking (Chassin et al. 1990, Birge et al. 2018), and is therefore considered a valid and important indicator of smoking in this age group. It is also the standard tobacco-use indicator used in the WHO's Global Youth Tobacco Survey, and therefore allows international comparison. Regular smoking (Yes/No) was based on the question 'How often do you smoke now?' The answer categories were: 'I have never smoked/I am not a smoker now'; 'At least once a day'; 'At least once a week'; 'At least once a month'; and 'Less often than once a month'.

Smoking status of mother, father, older sibling(s), and best friend were based on the question 'Which of the following people smoke?' with a dichotomous variable (current smoker, Yes/No) created for each. Previous research shows that maternal smoking is more strongly associated with adolescent smoking than paternal smoking (Leonardi-Bee et al. 2011). Therefore we examined exposure to maternal and paternal smoking separately. For the purposes of multivariable analysis, parental smoking was grouped into one variable, coded 0 = neither parent smokes, 1 = only mother smokes, 2 = only father smokes, 3 = both parents smoke.

Past week exposure to smoking in the home was based on the question 'During the past 7 days, on how many days have people smoked around you in your home?' Response categories were 0 days, 1-2 days, 3-4 days, 5-6 days and 7 days. For descriptive analysis, we recoded the responses into a dichotomous variable: past week exposure (Yes/No). To investigate whether prevalence of daily exposure changed over the study period, we also re-coded past week exposure into three categories: 'Daily exposure' (7 days) 'Less than daily exposure' (1-6 days) and 'No exposure' (0 days).

Demographic variables were age (14 or 15 years old), sex (male or female), ethnicity[13] (prioritised Māori, Pasifika,[14] Asian, NZ European/other [NZEO]); and school decile. School decile is calculated by the Ministry of Education for purposes of funding allocation, and is a school-level measure of the socio-economic status of a school's student community. School decile reflects the proportion of students at a school who are from low socio-economic neighbourhoods, based on small-area (meshblock) Census data on five indicators: household income, household crowding, parental educational qualifications, proportion of parents on income support benefits, and occupational skill level of employed parents. Further details of how school decile is calculated are available from the Ministry of Education (Ministry of Education 2017). For descriptive analysis only, we grouped school decile into low (deciles 1-3: most deprived), medium (4-7), and high (8-10: least deprived). Each school also had an identification number (school ID) which was assigned to all respondents from that school.

Analysis

First, we investigated the extent to which the included sample was representative of the New Zealand Year 10 population by comparing the characteristics of the included respondents and the New Zealand Year 10 population with respect to school decile, ethnicity and gender. We also examined changes in the demographic makeup of the sample and population over time.

To investigate the extent to which parental, sibling and best friend smoking and exposure to smoking in the home were associated with regular smoking in adolescents in the New Zealand context, we conducted multivariable logistic regression to determine the strength of the relationship between each predictor and regular smoking for each year. Model 1 adjusted for demographic factors only (sex, age, ethnicity and school decile) to control for confounding by these factors and Model 2 adjusted for demographic factors (as in Model 1) plus the other predictors of interest to determine the independent relationship of each to adolescent smoking. To adjust for potential clustering at the school level, school ID was entered as a random effect in all multivariable models.

Because Māori adolescents are a key priority group for smoking prevention, we re-coded ethnicity into Māori (Yes/No) and repeated the analysis above for Māori only to test whether associations differed for Māori.

[13] Note that students could select as many ethnicities as relevant. For analysis a single ethnicity was allocated using the Ministry of Health prioritisation method.
[14] Pasifika refers to New Zealanders of Pacific Island decent, predominantly from Samoa, the Cook Islands, Tonga and Niue.

To describe trends, we tabulated and plotted prevalence of regular smoking and prevalence of exposure to risk factors (overall and by sex, ethnicity and school decile) for each year. We then quantified the mean annual absolute change in proportion of respondents exposed to each risk factor using weighted linear regression (to adjust for differing variance by year by giving more weight to more accurate estimates of prevalence) with year as the independent variable. The weights were 1/standard deviation^2 of the proportions.

Next, for the years 2003 and 2006-2015, we conducted trend analyses based on individual-level data using multivariable logistic regression. We used SAS/STAT software (Version 9.4 of the SAS system for Windows) GLIMMIX procedure for this analysis. To test the extent to which the risk factors of interest accounted for the change over time in adolescent smoking in statistical terms, we modelled regular smoking as a function of survey year, adjusting for demographic factors (age, sex, ethnicity and school decile), and including school ID as a random effect to account for clustering at the school level (Model 1). We then added the risk factors of interest to Model 1, first individually then collectively. Statistically significant attenuation of the odds ratio (OR) for year, which was tested using Z tests to compare log odds, would indicate that the risk factor (partially) accounted for the trend over time.

Initially we modelled the trend using year as a continuous variable, which provided a single OR describing the average annual change in the odds of regular smoking over the study period. This approach assumes a linear trend over time, which may not be valid, so we also modelled the trend using year as a categorical variable. This provided an OR for regular smoking for each survey year 2006-2016, compared with the reference year.

To test whether the results of the trend analysis were different for Māori adolescents compared with the sample as a whole, we re-coded ethnicity into Māori (Yes/No) and repeated the trend analysis above for Māori only.

Results

Sample versus population, and changes in demographic composition over time

The final sample (N=398,221) comprised approximately half New Zealand's Year 10 population over the study period. We found the sample closely resembled the population in respect of demographic characteristics albeit with modest but consistent under-representation of Māori and students from low decile schools. A detailed comparison of the final included sample and population, by year, is provided in Appendix A.

According to Ministry of Education figures, the gender and age structure of the Year 10 population has remained stable over the 2002-2015 study period: 51% male, 49% female, with 78-80% aged 14 and 18-19% aged 15 at the mid-point of the year.

There is year-to-year variation in the school decile structure of the Year 10 population, but this has no clear temporal pattern: during the study period 18-22% of Year 10 students attended low decile schools, 42-48% medium decile schools and 33-40% high decile schools. Note that school deciles are applied to schools rather than individuals, and the lower proportion of students in low relative to high decile schools reflects that the latter tend to be larger schools.

Over the study period, the Year 10 population has become more ethnically diverse, with Māori, Pasifika and Asian students making up a greater proportion in recent years, as shown in Table 14. This change is reflected in the ASH Year 10 sample which has also become more ethnically diverse (Table 14).

Table 14: Ethnic composition of the Year 10 population and study sample, 2002-2015

	2002		2008		2015	
	Population*	**Study sample**	**Population**	**Study sample**	**Population**	**Study sample**
	N=58,812	N=28,088	N=61,485	N=29,682	N=59,528	N=20,443
NZEO	-	69%	59%	60%	55%	59%
Māori	-	17%	22%	19%	24%	21%
Pasifika	-	7%	9%	10%	10%	9%
Asian	-	8%	10%	11%	10%	11%

**Year 10 ethnicity data are not available from the Ministry of Education prior to 2006*

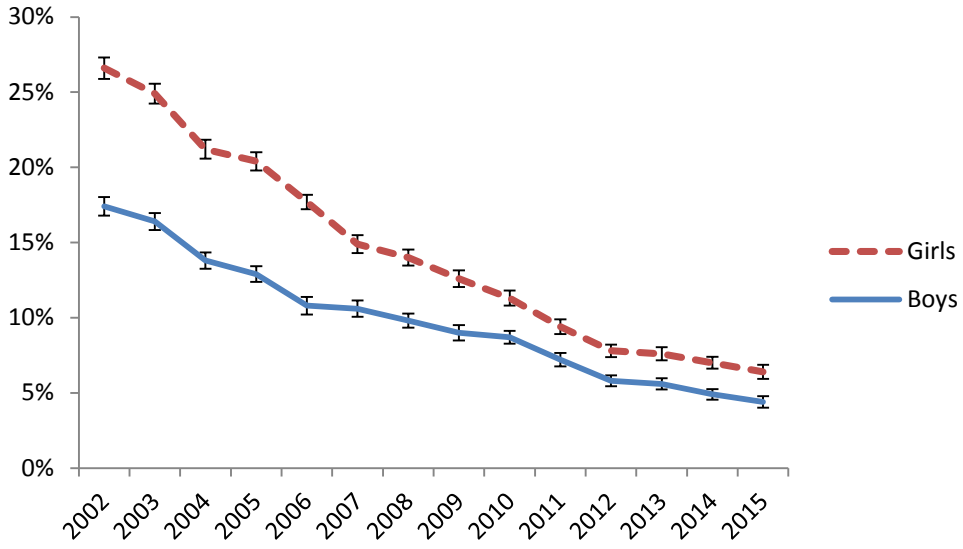
Prevalence of adolescent smoking

Regular smoking in Year 10 students declined markedly over the study period, from 22% in 2002 to 5% in 2015. Declines occurred in all main demographic groups by gender (Fig 24), ethnicity (Fig 25) and school decile (Fig 26).

Gender

Throughout the study period, girls were more likely to smoke than boys. In 2002 there was an absolute gap of 10% between boys' and girls' smoking prevalence (17 % and 27% respectively), which narrowed to around 2% in 2011 and has remained stable since then, as shown in Figure 24.

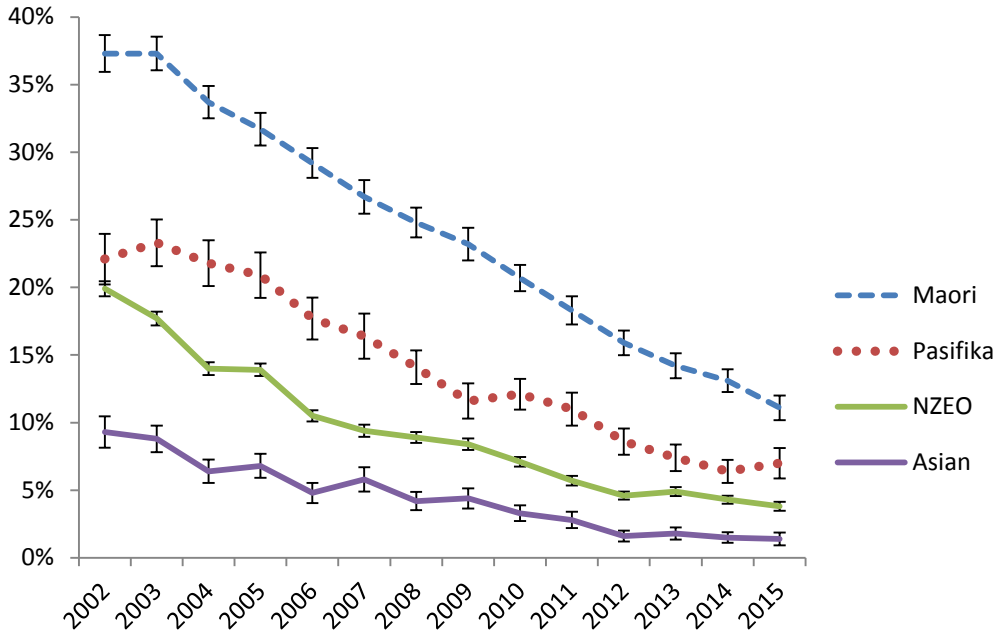
Figure 24: Prevalence (%) of regular smoking by gender, 2002-2015



Ethnicity

Adolescent smoking In New Zealand is strongly patterned by ethnicity, with Māori adolescents most likely to smoke, followed by Pasifika and New Zealand European/Other (NZEO). Asian adolescents are the least likely to smoke. As shown in Figure 25, in the initial two years of the study period (2002-2004) smoking declined fastest in the NZEO ethnic group, and absolute ethnic disparities peaked in 2004 when Māori smoking was 20% above NZEO in absolute terms (34% vs 14%). Since 2004 absolute ethnic differences have been narrowing. Māori have shown the fastest rate of decline in recent years, and the gap between Māori and NZEO narrowed to 7% in 2015 (11% vs 4%). The absolute gap between Pasifika and NZEO also peaked in 2004, when it was 8% (22% vs 14%) and reached a minimum of 2% in 2014.

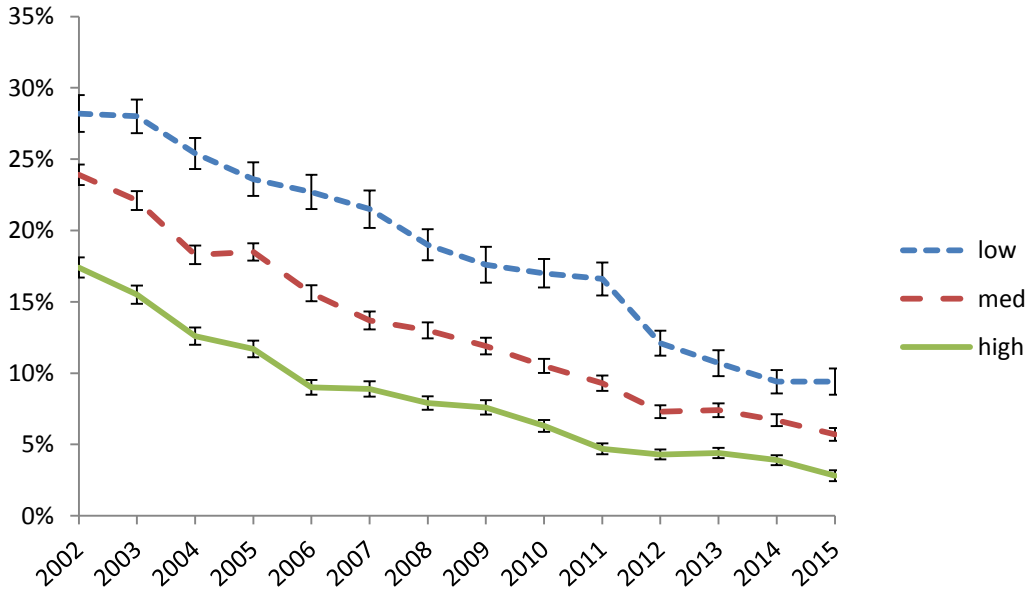
Figure 25: Prevalence (%) of regular smoking by ethnicity, 2012-2015



School decile

Adolescent smoking is also strongly patterned by school decile, as shown in Figure 26. The difference between students from high and low decile schools peaked in 2006 at 14% in absolute terms, with smoking prevalence at 9% in students from high decile schools and 23% in students from low decile schools. By 2014 the gap had reached a low point of 5.5%.

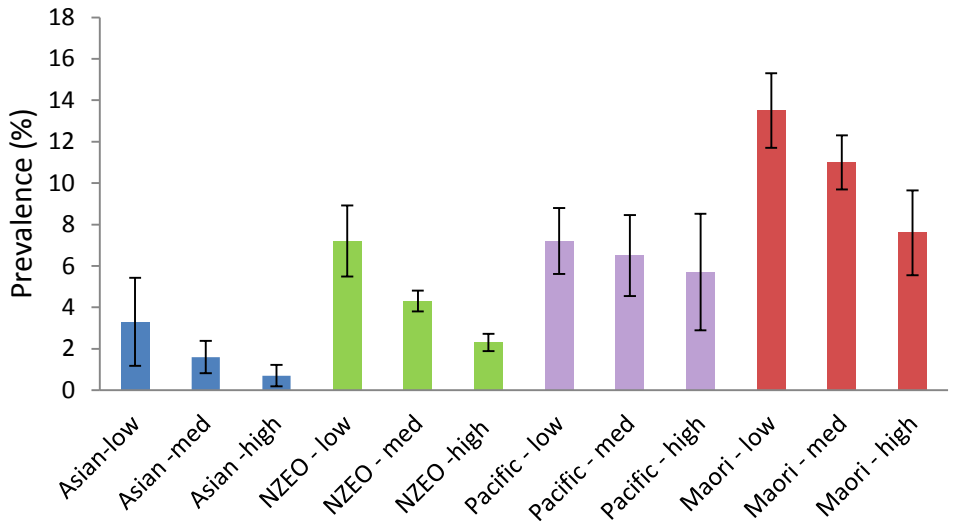
Figure 26: Prevalence (%) of regular smoking by school decile, 2002-2015



Despite absolute differences closing, smoking remains strongly patterned by ethnicity and school decile and is becoming increasingly concentrated in Māori, Pasifika and low decile groups, since smoking prevalence is nearing zero in other groups.

When smoking prevalence for 2015 is stratified by school decile and ethnicity (Fig 27), a clear social gradient within each ethnic group can be observed, as well as stark differences by ethnicity.

Figure 27: Prevalence (%) of regular smoking by ethnicity and school decile, 2015



Daily smoking is much less common in Year 10 students than regular (at least monthly) smoking, but findings for daily smoking follow similar patterns to those described above. Prevalence of daily smoking fell from 12% in 2002 to 2.5% in 2015, and declined in all demographic groups, with bigger absolute declines in girls, Māori, and students from low decile schools over the study period (data not shown).

Association between risk factors and regular smoking

Multivariable modelling confirmed that, after adjusting for age, sex, and school decile (Model 1), smoking status of best friend, older sibling(s), and parents were all strongly associated with smoking in Year 10 students, as was exposure to smoking in the home. These associations were significant throughout the study period, with results for 2003 and 2015 (the first and last years for which all variables of interest were available) shown in Table 15.

In the fully adjusted model (Model 2), which included all the predictor variables as well as demographic factors, strong and statistically significant associations remained for smoking

status of best friend and older sibling(s) and exposure to smoking in the home. In contrast, parental smoking had only a weak (2003) or non-significant (2015) association with regular smoking in the fully adjusted model.

Table 15: Strength of association between risk factors and regular smoking, 2003 & 2015

	Year 10 Students (aged 14-15 years)			
	2003 (N=31,337)		**2015** (N = 20, 443)	
	Model 1: Odds ratio, adjusted for demographic factors (95% CI)	Model 2: Odds ratio, fully adjusted (95% CI)	Model 1: Odds ratio, adjusted for demographic factors (95% CI)	Model 2: Odds ratio, fully adjusted (95% CI)
No exposure to smoking in the home (0 days)	1.0	1.0	1.0	1.0
Less than daily exposure to smoking in the home (1-6 days)	**2.1 (1.9. 2.3)**	**1.4 (1.3, 1.6)**	**3.7 (3.1, 4.4)**	**2.6 (2.1, 3.1)**
Daily exposure to smoking in the home (7 days)	**3.4 (3.2, 3.6)**	**1.8 (1.7, 2.0)**	**7.3 (6.2, 8.5)**	**3.3 (2.7, 4.1)**
Neither parent smokes	1.0	1.0	1.0	1.0
Only mother smokes	**2.3 (2.1, 2.5)**	**1.3 (1.2, 1.5)**	**3.2 (2.6, 3.8)**	1.2 (1.0, 1.5)
Only father smokes	**1.8 (1.7, 2.0)**	**1.3 (1.2, 1.4)**	**2.3 (1.9, 2.8)**	1.2 (0.9, 1.5)
Both parents smoke	**3.6 (3.3, 3.9)**	**1.4 (1.2,1.5)**	**4.8 (4.0, 5.6)**	1.2 (1.0, 1.5)
Older sibling smokes (ref: no older sibling who smokes)	**3.1 (3.0, 3.3)**	**2.1 (1.9, 2.2)**	**3.8 (3.3, 4.3)**	**1.7 (1.5, 2.0)**
Best friend smokes (ref: best friend does not smoke)	**10.2 (9.5, 10.8)**	**8.4 (7.9, 9.0)**	**17.1 (14.9, 19.7)**	**11.8 (10.1, 13.6)**

*Odds ratios with a statistically significant (p<.001) difference from the reference are presented in **bold.** Demographic factors were age, sex, ethnicity and school decile. The fully adjusted models (Model 2) include demographic factors and exposure to smoking in the home, parental smoking, sibling smoking, best friend smoking.*

The strongest predictor of regular smoking throughout the study period was the smoking status of respondents' best friend, with a fully adjusted OR of 8.4 (95% CI 7.9, 9.0) in 2003 and 11.8 (10.1, 13.6) in 2015 (Table 15).

An unexpected finding was that some risk factors had an increasing strength of association with adolescent smoking over time. For example, as noted above and shown in Table 3, the fully adjusted OR for best friend smoking increased markedly over the study period, as did ORs for less than daily and daily exposure to smoking in the home. In contrast, there was little change in adjusted ORs for parental and sibling smoking between 2003 and 2015.

Table 16 shows the results of the analysis for Māori adolescents and shows that the patterns described above also held for Māori adolescents. However the increase over time in adjusted OR for exposure to smoking in the home was more marked in Māori than non-Māori. Supplementary analysis, using ethnicity (Māori/non-Māori) as an interaction term with each risk factor confirmed the adjusted OR for exposure to smoking in the home in 2015 was higher in Māori than non-Māori ($p<0.01$), an ethnic difference which was not present in 2003.

Table 16: Strength of association between risk factors and regular smoking, Māori, 2003 & 2015

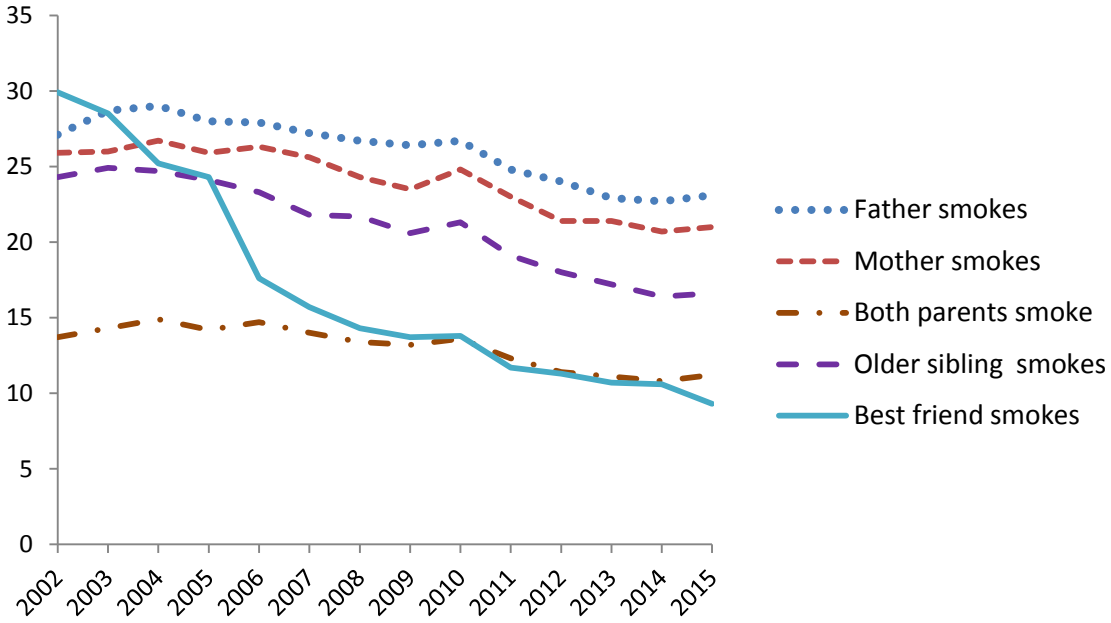
	Māori Year 10 Students (aged 14-15 years)			
	2003 (N=5,425)		**2015** (N=4,215)	
	Model 1: Odds ratio adjusted for demographic factors (95% CI)	Model 2: Odds ratio fully adjusted (95% CI)	Model 1: Odds ratio adjusted for demographic factors (95% CI)	Model 2: Odds ratio fully adjusted (95% CI)
No exposure to smoking in the home (0 days)	1.0	1.0	1.0	1.0
Less than daily (1-6 days) exposure to smoking in the home	**2.0 (1.6, 2.4)**	**1.6 (1.3, 2.0)**	**3.6 (2.7, 4.8)**	**2.8 (2.1, 3.9)**
Daily (7 days) exposure to smoking in the home	**2.8 (2.4, 3.1)**	**1.9 (1.6, 2.1)**	**6.8 (5.2, 8.9)**	**4.2 (3.0, 5.9)**
Neither parent smokes	1.0	1.0	1.0	1.0
Only mother smokes	**2.0 (1.7, 2.3)**	**1.3 (1.1, 1.6)**	**2.1 (1.6, 2.9)**	0.8 (0.5, 1.1)
Only father smokes	**2.0 (1.6, 2.7)**	**1.5 (1.2, 1.8)**	**1.8 (1.3, 2.5)**	0.9 (0.6, 1.3)
Both parents smoke	**2.7 (2.3, 3.1)**	1.2 (1.0, 1.4)	**3.6 (2.8, 4.7)**	0.9 (0.7, 1.3)
Older sibling smokes	**2.3 (2.1, 2.6)**	**1.6 (1.4, 1.9)**	**2.8 (2.3, 3.5)**	**1.5 (1.2, 1.9)**
Best friend smokes	**6.5 (5.7, 7.3)**	**5.5 (4.8, 6.3)**	**11.0 (8.9, 13.7)**	**8.2 (6.5, 10.2)**

*Odds ratios with a statistically significant (p<.001) difference from the reference are presented in **bold.** Demographic factors were age, sex and school decile. The fully adjusted model includes demographic factors and exposure to smoking in the home, parental smoking, sibling smoking, best friend smoking.*

Changes in exposure to risk factors over time

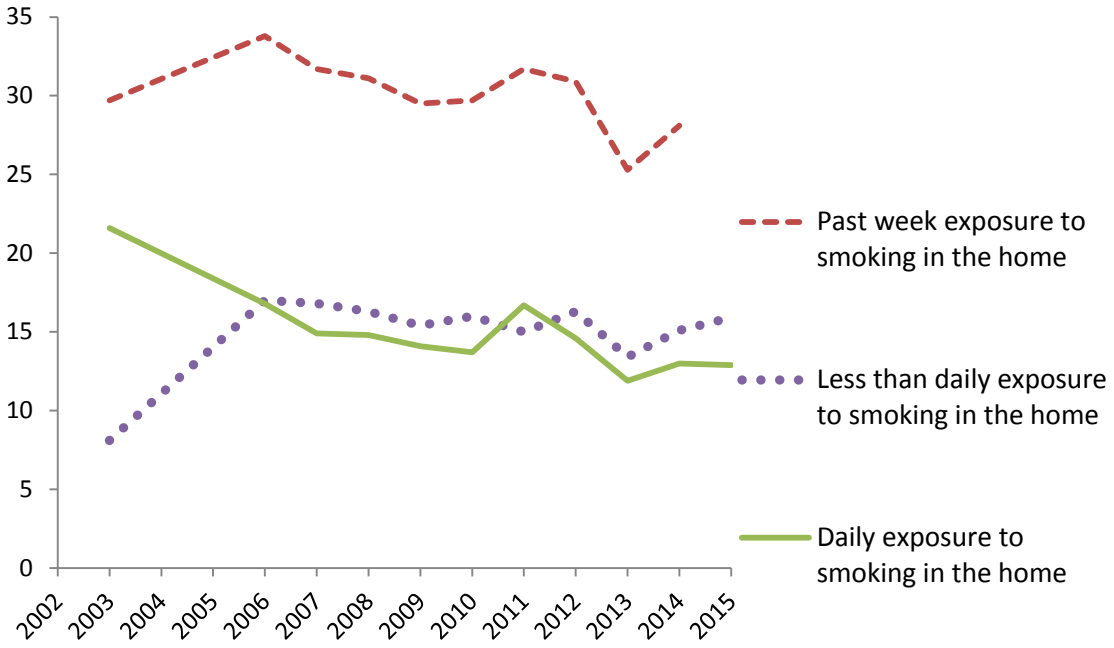
Trends in exposure to risk factors are shown in Figures 28 and 29 below. The proportion of students who reported that their parents smoked (Fig 28) declined only modestly over the study period with maternal and paternal smoking both declining by an average rate of 0.5% per annum, based on weighted linear regression. Smoking among older siblings (Fig 28) declined slightly more, at an average rate of 0.7% per annum, and best friend smokes (Fig 28) had the highest rate of decline at 1.5% per annum.

Figure 28: Prevalence (%) of parental, sibling and best friend smoking, 2002-2015



As shown in Figure 29, the prevalence of past week exposure to smoking in the home did not change significantly between 2002 (30%) and 2015 (28%). However, prevalence of daily exposure fell from 22% to 13% (an average decrease of 0.6% per annum), with most of the decline concentrated in the period between 2003 to 2007. Less than daily exposure increased over approximately the same period.

Figure 29: Prevalence (%) of past week exposure to smoking in the home, 2003-2015

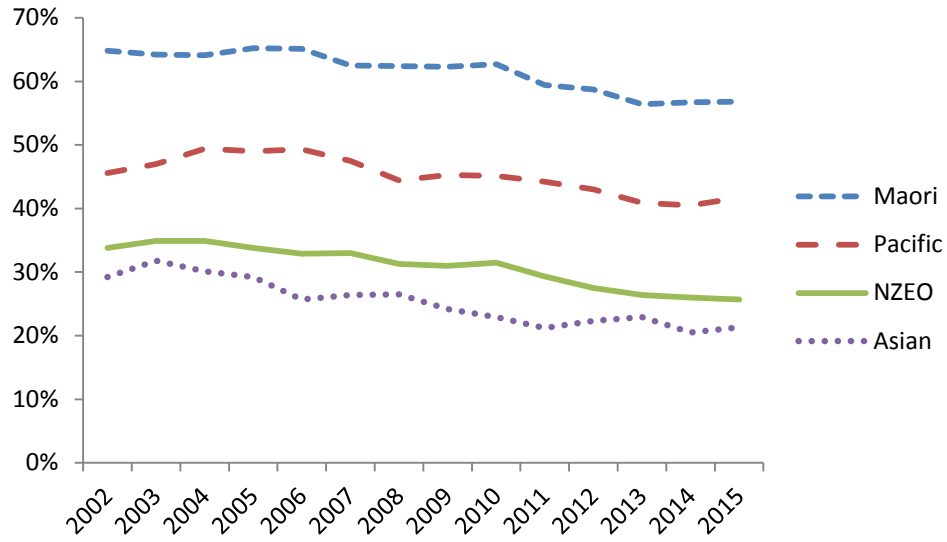


We explored whether trends in exposure to risk factors differed by ethnicity or school decile, since differences in adolescent smoking are marked by these demographic variables but have narrowed (in absolute terms) over time. Could greater decline in exposure to smoking predictors over time in Māori, Pasifika and students from low decile schools explain the narrowing of ethnic and socio-economic differences?

Parental smoking

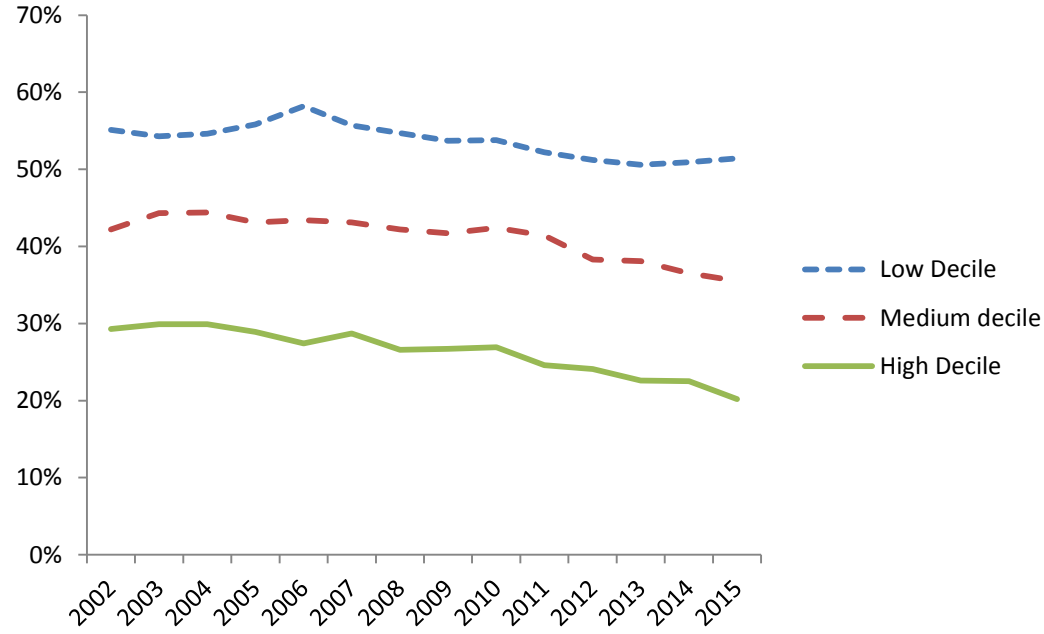
We found that parental smoking was strongly patterned by students' ethnicity, and as Figure 30 shows, ethnic disparities in exposure to parental smoking (at least one parent smokes) did not narrow over time.

Figure 30: Prevalence (%) of parental smoking by ethnicity, 2002-2015



As shown in Figure 31, parental smoking declined slightly more among students attending high compared to low decile schools. The absolute difference in exposure to parental smoking between high and low deciles increased from 26% to 31% over the study period.

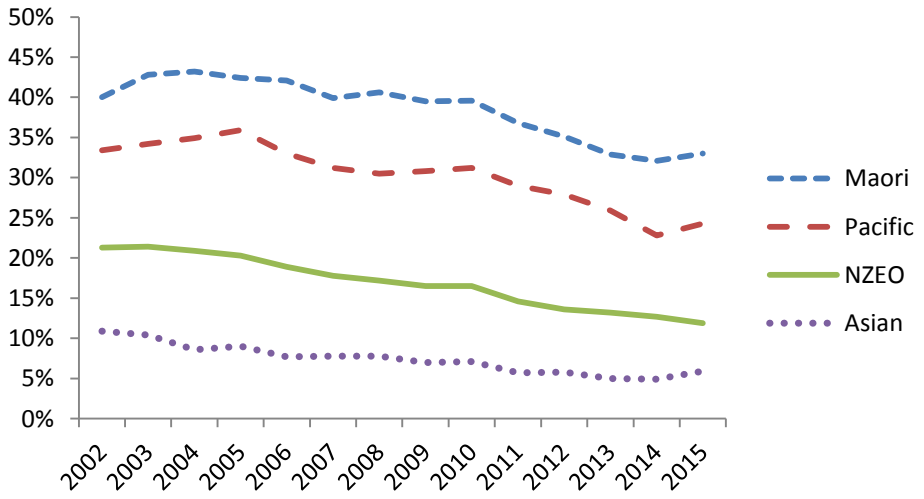
Figure 31: Prevalence (%) of parental smoking by school decile, 2002-2015



Older sibling smoking

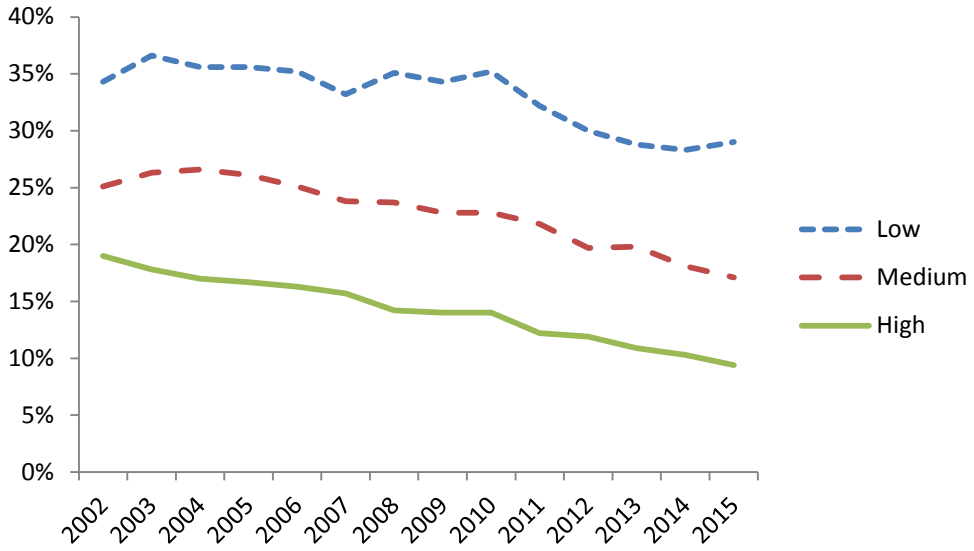
As shown in Figure 32, the proportion who reported having an older sibling who smoked did not decline in the first few years of the study period, and in fact increased slightly for Māori and Pasifika students. This is likely to reflect the fact that smoking peaked in Year 10 students in the late 1990s (peaking in 2000 for Māori). It is likely that this cohort (containing a high proportion of smokers) became the older siblings of the Year 10 students surveyed in the early 2000s. In the sample as a whole, the decline in the proportion of Year 10 students reporting older sibling smoking began in 2005, and accelerated from 2010, the year annual 10% tax increases were introduced in New Zealand. Ethnic differences in exposure to sibling smoking are marked and absolute differences have changed little over time.

Figure 32: Proportion (%) with older sibling(s) who smoke(s) by ethnicity, 2002-2015



The proportion reporting older sibling smoking also differed markedly by school decile (Figure 33) with absolute differences in exposure between low and high decile increasing from 15% in 2002 to 19% in 2015.

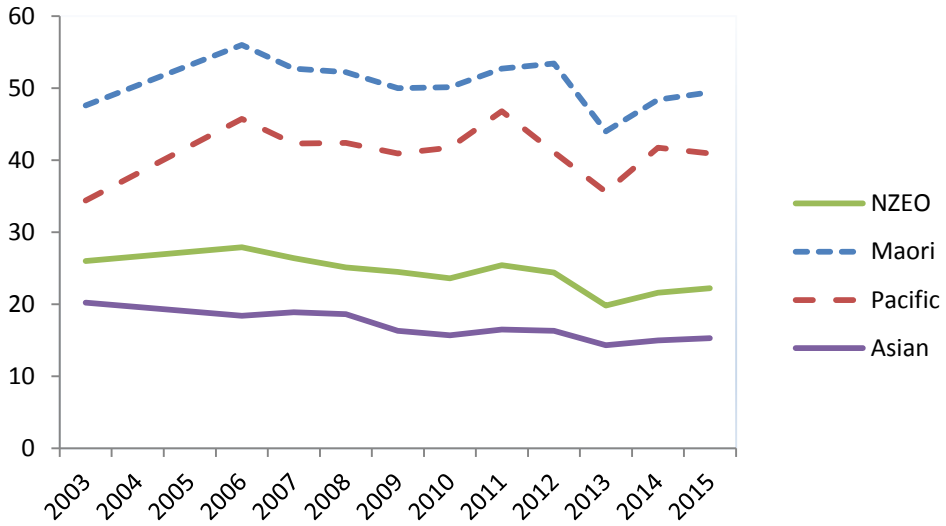
Figure 33: Proportion (%) with older sibling(s) who smoke(s) by school decile, 2002-2015



Exposure to smoking in the home

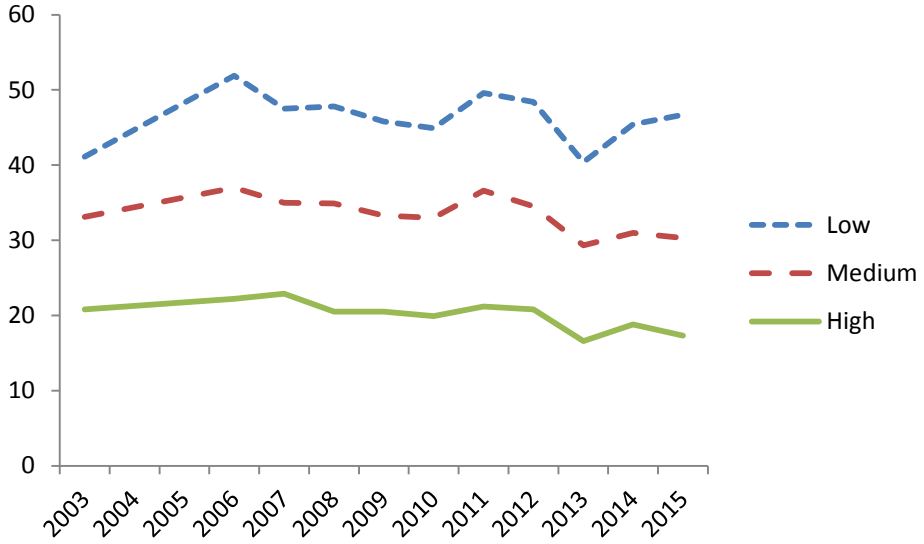
We found that, like other predictors, past week exposure to smoking in the home was strongly patterned by students' ethnicity, and, as Figure 34 shows, the absolute difference between Māori (the most exposed group) and Asian (the least exposed) increased slightly over the study period, from 27% in 2003 to 34% in 2015. Māori and Pasifika students' exposure fluctuated, but between 2003 and 2015 Pasifika students' exposure increased from 34% to 41%, while Māori students' exposure was unchanged at 48-49% and NZEO and Asian students' exposure declined from 26 to 22% and 20% to 15% respectively.

Figure 34: Prevalence (%) of past week exposure to smoking in the home, by ethnicity, 2003-2015



Absolute differences in prevalence of exposure by school decile also increased over the study period (Figure 35). The proportion of students exposed declined from 21% to 17% in high decile schools, but rose from 41% to 47% in low decide schools.

Figure 35: Prevalence (%) of past week exposure to smoking in the home by decile, 2003-2015



Smoking status of best friend

Unsurprisingly, we found that, as smoking declined over time in Year 10 students, fewer respondents reported that their best friend smoked. As with other predictors, marked socio-economic and ethnic differences were apparent. However, unlike other predictors, these differences narrowed in absolute terms over the study period. Figure 36 shows best friend smoking by ethnicity and Figure 37 shows best friend smoking by school decile.

Figure 36: Proportion (%) reporting best friend smokes, by ethnicity, 2002-2015

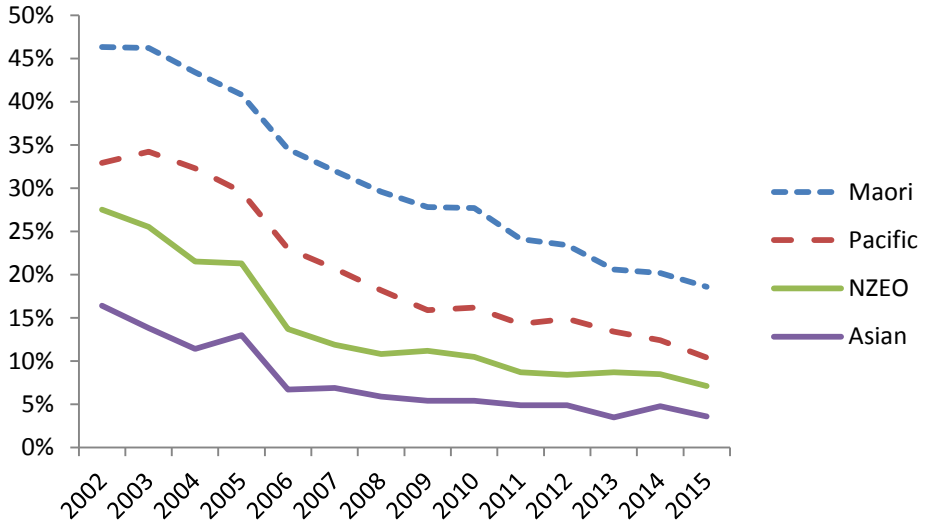
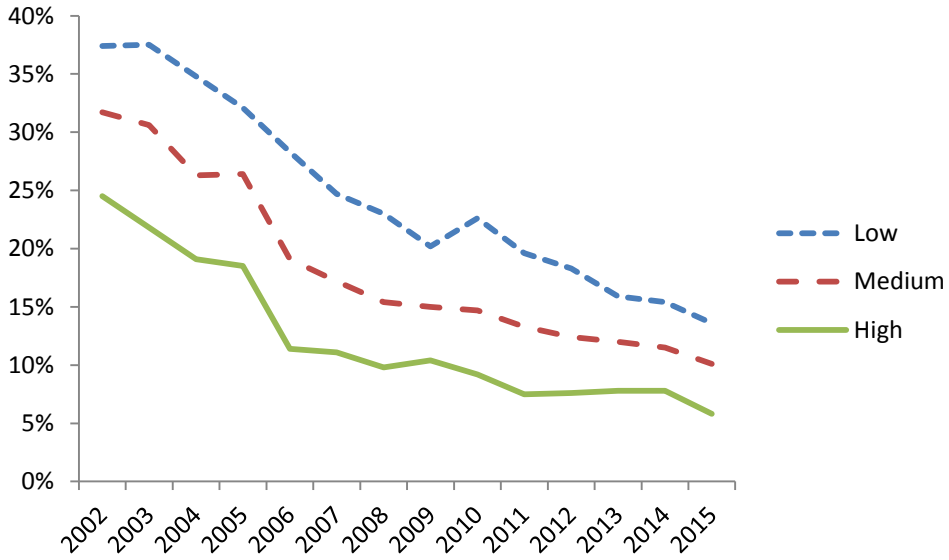


Figure 37: Proportion (%) reporting best friend smokes, by school decile, 2002-2015



Trend analysis

Results of the trend analyses are shown in Table 17. We observed a strong downward trend in regular smoking among Year 10 students, with an OR of 0.88 per year (95% CI 0.88, 0.88, p<.001) based on the linear trend. As shown in Table 17, when 'best friend smokes' was added to the model (Model 1 + Best friend smokes) the adjusted OR was significantly attenuated (i.e. it moved closer to the null) compared with Model 1, indicating that this risk factor partially (but not fully) accounted for the declining trend in adolescent smoking between 2003 and 2015. None of the other risk factors, when added to Model 1, significantly attenuated the OR for year relative to the reference year, indicating that, individually, they did not contribute to the trend**.**

When all four predictors were entered into the model together (Model 1+ all risk factors – the right hand column in Table 17), the attenuation of the OR was significant (p<.05) but the magnitude of the change was no greater than for 'Model 1 + Best friend smokes'.

The pattern of results described above was observed regardless of whether year was used as a categorical variable (modelling change relative to 2003 for each year, Table 17), or a continuous variable (modelling the linear trend, to give an annual average change over the study period, as shown in the final row of Table 17).

Table 17: Results of trend analyses examining the impact of tobacco-specific risk factors on the trend for regular smoking, 2003-2015

Year	Model 1: OR for Year partially adjusted (95% CI)	Model 1 + Best friend smokes (95% CI)	Model 1 + Exposure to smoking in home (95% CI)	Model 1 + Parental smoking	Model 1 + Sibling smoking	Model 1 + all four predictors
2003	1					
2006	0.62 (0.59, 0.64)	0.83* (0.78, 0.87)	0.58 (0.55, 0.61)	0.60 (0.57, 0.63)	0.61 (0.58, 0.64)	0.75* (0.71, 0.79)
2007	0.56 (0.53, 0.59)	0.78* (0.74, 0.83)	0.54 (0.52, 0.57)	0.55 (0.52, 0.58)	0.56 (0.54, 0.59)	0.72* (0.68, 0.76)
2008	0.51 (0.48, 0.53)	0.74* (0.70, 0.79)	0.49 (0.47, 0.52)	0.50 (0.48, 0.53)	0.51 (0.48, 0.53)	0.68* (0.64, 0.72)
2009	0.47 (0.44, 0.49)	0.69* (0.65, 0.73)	0.46 (0.43, 0.49)	0.46 (0.44, 0.49)	0.47 (0.45, 0.50)	0.63* (0.59, 0.67)
2010	0.40 (0.38, 0.42)	0.58* (0.54, 0.61)	0.40 (0.38, 0.42)	0.39 (0.37, 0.41)	0.40 (0.38, 0.42)	0.53* (0.50, 0.57)
2011	0.36 (0.34, 0.38)	0.55* (0.51, 0.58)	0.33 (0.31, 0.35)	0.36 (0.34, 0.38)	0.37 (0.35, 0.39)	0.47* (0.44, 0.51)

Year	Model 1: OR for Year partially adjusted (95% CI)	Model 1 + Best friend smokes (95% CI)	Model 1 + Exposure to smoking in home (95% CI)	Model 1 + Parental smoking	Model 1 + Sibling smoking	Model 1 + all four predictors
2012	0.28 (0.27, 0.30)	0.42* (0.39, 0.45)	0.26 (0.25, 0.28)	0.29 (0.27, 0.30)	0.29 (0.27, 0.31)	0.37* (0.35, 0.40)
2013	0.27 (0.25, 0.28)	0.41* (0.39, 0.44)	0.28 (0.26, 0.29)	0.27 (0.26, 0.29)	0.28 (0.26, 0.30)	0.39* (0.37, 0.42)
2014	0.24 (0.22, 0.25)	0.36* (0.34, 0.39)	0.23 (0.22, 0.25)	0.24 (0.23, 0.26)	0.25 (0.24, 0.27)	0.34* (0.32, 0.36)
2015	0.21 (0.19, 0.22)	0.34* (0.32, 0.37)	0.20 (0.19, 0.22)	0.21 (0.20, 0.23)	0.22 (0.21, 0.24)	0.31* (0.29, 0.34)
All years combined, using year as a continuous variable						
Linear trend (2003-2015)	0.88 (0.88, 0.88)	0.91* (0.91,0.92)	0.88 (0.88, 0.88)	0.88 (0.88,0.89)	0.88 (0.88, 0.89)	0.91* (0.90, 0.91)

Model 1 is adjusted for age, gender, ethnicity and school decile.

**OR significantly greater than Model 1 (p < .05)*

The same overall patterns were also seen in Māori respondents, as shown in Table 18.

Table 18: Māori-specific results of trend analyses examining the impact of tobacco-specific risk factors on the trend for regular smoking, 2003-2015

Year	Model 1 OR for Year, partially adjusted	Model 1 + Best friend	Model 1 + smoke in home	Model 1 + parental smoking	Model 1 + smoke Sibling	Model 1 + all risk factors
2003	1					
2006	0.73 (0.67, 0.79)	0.89* (0.81, 0.97)	0.68 (0.62, 0.74)	0.70 (0.65, 0.77)	0.72 (0.66, 0.78)	0.80 (0.73, 0.88)
2007	0.64 (0.58, 0.70)	0.78* (0.71, 0.87)	0.61 (0.55, 0.67)	0.62 (0.57, 0.69)	0.63 (0.58, 0.70)	0.73 (0.66, 0.81)
2008	0.57 (0.52, 0.62)	0.75* (0.68, 0.82)	0.55 (0.49, 0.60)	0.56 (0.51, 0.61)	0.56 (0.51, 0.62)	0.69* (0.62, 0.76)
2009	0.52 (0.48, 0.58)	0.70* (0.63,0.78)	0.50 (0.46, 0.56)	0.51 (0.46, 0.56)	0.52 (0.47, 0.57)	0.65* (0.58, 0.72)
2010	0.46 (0.42, 0.50)	0.59* (0.54, 0.65)	0.45 (0.41, 0.49)	0.45 (0.41, 0.49)	0.45 (0.41, 0.49)	0.55* (0.50, 0.61)
2011	0.42 (0.38, 0.46)	0.58* (0.52, 0.64)	0.38 (0.34, 0.41)	0.42 (0.38, 0.46)	0.42 (0.38, 0.46)	0.51* (0.45, 0.56)
2012	0.34 (0.31, 0.38)	0.47* (0.42, 0.52)	0.31 (0.28, 0.34)	0.34 (0.31, 0.38)	0.35 (0.31, 0.38)	0.42* (0.37, 0.46)
2013	0.31	0.44*	0.31	0.31	0.31	0.42*

Year	Model 1 OR for Year, partially adjusted	Model 1 + Best friend	Model 1 + smoke in home	Model 1 + parental smoking	Model 1 + smoke Sibling	Model 1 + all risk factors
	(0.28, 0.34)	(0.40, 0.49)	(0.28, 0.34)	(0.28, 0.34)	(0.28, 0.35)	(0.38, 0.47)
2014	0.28 (0.26, 0.31)	0.40* (0.36, 0.45)	0.27 (0.24, 0.30)	0.29 (0.26, 0.32)	0.29 (0.26, 0.32)	0.37* (0.33, 0.42)
2015	0.23 (0.21, 0.26)	0.34* (0.34, 0.39)	0.22 (0.19, 0.25)	0.23 (0.21, 0.26)	0.24 (0.21, 0.27)	0.32* (0.28, 0.36)
All years combined, using year as a continuous variable						
Linear trend 2003-2015	0.89 (0.88, 0.89)	0.92* (0.91, 0.92)	0.89 (0.88, 0.89)	0.89 (0.88, 0.90)	0.89 (0.89, 90)	0.91* (0.90, 0.92)

Model 1 is adjusted for age, gender, ethnicity and school decile.
**OR for year significantly greater than Model 1 ($p < .05$)*

There was a residual effect of year (i.e. unexplained change over time indicated by an OR for year that was significantly less than 1) in all the models, including the fully adjusted models in the right hand column. This indicates that there were factors outside the model that were influencing the change over time in smoking prevalence.

Discussion

This analysis shows that regular smoking declined dramatically between 2002 and 2015 in New Zealand Year 10 students (aged 14-15) in all main demographic groups. Although tobacco use remained strongly patterned by ethnicity and school decile throughout the study period, smoking declined to a greater extent in disadvantaged ethnic and socio-economic groups and therefore absolute disparities in adolescent smoking prevalence reduced over the study period. Gender differences were less marked but also reduced over the study period. The results showed that sibling smoking, exposure to smoking in the home, and best friend smoking were all significant independent risk factors for adolescent smoking throughout the study period, while parental smoking was a weak or non-significant factor in fully adjusted models. Exposure to best friend smoking decreased substantially during the 2002-2015 period, whilst exposure to other predictors decreased more modestly, if at all.

The primary aim of the study was to determine whether these known predictors explained (in statistical terms) the dramatic decline in adolescent smoking seen recently in New Zealand. The trend analysis shows that best friend smoking was the only variable that (partially)

explained the decline in adolescent smoking 2002-2015. The other included factors – parental and sibling smoking, and exposure to smoking in the home – did not contribute to the trend either individually or collectively. The findings suggest that the decline in adolescent smoking is not the result of adolescents following behavioural models in the home environment.

An initial question to consider is, was the observed decline in adolescent smoking real, or an artefact of bias or methodological changes? The latter seems unlikely. The only major methodological change during the study period was a change in fieldwork timing between 2010 and 2011. Such a change could not account for the steady decline observed in smoking prevalence over time. Furthermore, a step-change in regular smoking prevalence is not observable between 2010 and 2011 (when fieldwork timing was changed, resulting in respondents being 2-3 months younger on average in 2011 and subsequent years than 2010 and previous years). Therefore, I consider that any impact of methodological changes is likely to be negligible.

Another way in which bias could potentially impact on the study findings would be an increase in social desirability bias over time, resulting in an exaggeration of the reported decline in adolescent smoking. To test the validity of self-reported smoking in the ASH Year 10 survey, the Health Promotion Agency undertook biomarker validation in a subset of the ASH Year 10 sample in 2015. The study confirmed that self-reported smoking prevalence corresponded closely with that determined via objective measures (Sunseri & White 2017). This suggests that any increase in social desirability bias (due to decreasing social acceptability of smoking) made little, if any, contribution to the decline in self-reported smoking among adolescents over the study period. I conclude that the decline (or at least, the majority of it) is real and not an artefact.

In the analysis of the relationships between risk factors and adolescent smoking, there were marked differences between partially adjusted (controlling for demographic variables only) and fully adjusted ORs, suggesting substantial confounding or mediation by other predictors in the model. This is consistent with previous research showing that smoking clusters at the neighbourhood level (Frohlich et al. 2002), and has become increasingly concentrated in low-socio-economic and Indigenous/ethnic-minority communities, and in certain occupational groups (Graham et al. 2006, Graham 2011, Hefler & Chapman 2015). As a result, adolescents tend to move in smoking or non-smoking circles, and therefore parental, sibling and best friend's smoking status are not independent but are strongly related to one other. Unsurprisingly, parental smoking and exposure of adolescents to smoking in the home are also

strongly related, and in bivariate analyses both factors were strongly associated with adolescent smoking. However, in multivariable modelling, the association between parental smoking and adolescent smoking became weak or non-existent, suggesting that other predictors in the model (e.g. exposure to smoking in the home) mediated or confounded (or both) the relationship between parental smoking and adolescent smoking.

The increasing association over time between certain risk factors (exposure to smoking in the home and best friend smoking) and adolescent smoking was an unexpected finding, and one with important implications for prevention. We explored these findings in depth and discussed their implications in a recent publication (Ball et al. 2018a). However, as they are not directly related to the research questions at hand they are not discussed in detail here.

Given recent efforts to denormalise indoor smoking in New Zealand (Edwards et al. 2008) the fact that prevalence of past week exposure to smoking in the home changed little over the study period was also unexpected. Since exposure to smoking in the home did not decline markedly, and its association with adolescent smoking became stronger over time, it is unsurprising that this variable did not contribute to the decline in adolescent smoking over the study period.

Although exposure to parental smoking, sibling smoking and best friend smoking all declined over the study period, only best friend smoking contributed to the decline in adolescent smoking, in statistical terms. It is understandable that parental smoking did not contribute to the decline in adolescent smoking, since it was not an independent risk factor in most years in fully adjusted models. However it is surprising that sibling smoking did not contribute, since its independent relationship with adolescent smoking was relatively strong and the proportion of Year 10 students exposed declined significantly over time. The slight increase over time in the strength of association between sibling smoking and adolescent smoking may explain this finding.

That ‘best friend smokes’ was a contributor was expected, given it was by far the strongest predictor of adolescent smoking throughout the study period, and exposure declined markedly over time. However it is questionable whether this finding contributes to our understanding of the drivers of population level decline since respondents and their best friends largely belong to the same population in which smoking is declining. Hence to claim that a decline in best friend smoking is a driver of adolescent smoking decline appears to be a circular argument at the population level.

However, our findings underline the central importance of peers in smoking uptake and suggest the possibility of a peer feedback loop. Diffusion of innovations (Haider & Kreps 2004) and social contagion theory (Christakis & Fowler 2013) provide theoretical models for how behaviour 'spreads' through a population. The fact that adolescents are so strongly influenced by their friends may mean that small changes in the prevalence of smoking uptake are quickly amplified. For example, if smoking uptake increases in a cohort (compared to previous cohorts) at time 1, this will result in more pro-smoking peer influence and (probably) greater peer supply of cigarettes within the cohort. This will lead to increased smoking prevalence at time 2, which in turn will further increase pro-smoking influence and peer supply, and so on. Since young people often emulate the behaviour of those slightly older than themselves, smoking behaviour would spread not only across a cohort over time, but also to younger cohorts. This peer feedback loop may help to explain why smoking increased rapidly among adolescents, but not adults, in the early 1990s. The same processes may have happened in reverse from the late 1990s with a decline in adolescent smoking at time 1 leading to a subsequent decline in adolescent smoking at time 2 and so on. As Aström and Murray explain:

> *Simple causal reasoning about a feedback system is difficult because the first system influences the second and second system influences the first, leading to a circular argument. This makes reasoning based upon cause and effect tricky, and it is necessary to analyze the system as a whole (Aström & Murray 2010, p 1).*

Further research, perhaps drawing on system dynamics methods (Homer & Hirsch 2006, Azar 2012), could test this feedback loop hypothesis and explore how the 'social transmission' of behaviour influences population prevalence over time. Should the feedback loop hypothesis prove to be correct, the trigger for the sudden change from rapidly rising to rapidly falling adolescent tobacco use from the late 1990s to the early 2000s still remains to be identified.

We found that results for Māori adolescents were similar to results for the sample as a whole; best friend smoking was the only included variable to contribute to declining smoking prevalence in this ethnic group. It is interesting to note that although absolute ethnic and socio-economic differences in adolescent *smoking prevalence* narrowed significantly over the study period, differences in *exposure to predictors* generally did not narrow (and in fact widened for some predictors). This is consistent with the finding that declines in adolescent smoking over the period are not explained by parental or sibling smoking or exposure to smoking in the home. Declines have occurred *in spite of*, rather than because of, smoking practices in the family setting, particularly for Māori, Pasifika and low decile students.

As far as I am aware, this is the first study to explore trends in exposure to known predictors with the purpose of better understanding the drivers of the decline in adolescent smoking prevalence. Definitively establishing the causes(s) of the decline in adolescent smoking is not possible using repeat cross-sectional data (or indeed via any single study). However, trend analysis using statistical modelling enables exploration of the mathematical relationships between survey year, predictors and outcomes, and thereby investigation of the degree to which these predictors 'explain' trends in adolescent smoking in statistical terms (in the absence of certainty about causality). This approach enables us to rule out some hypothesised explanations and adds to the evidence base about possible drivers of smoking decline in adolescents.

Strengths of the study include the large sample size, and demographic similarity between the sample and the Year 10 population, suggesting response bias was not a substantial issue. Systematic under- and over-representation of demographic groups was found to be relatively consistent over time and therefore unlikely to affect trend analysis, which was the focus of the study. As discussed above, the methods for the ASH survey were broadly consistent between years, with minor changes (e.g. a change in fieldwork timing from 2011) unlikely to contribute significantly to the trends observed. Since there is strong similarity between New Zealand and other countries at a late stage in the tobacco epidemic in terms of trends in adolescent smoking and known predictors, it is likely that the findings may be generalisable to similar countries, but this remains to be confirmed through further research.

The study was based on self-report questionnaire data, with its inherent limitations (e.g. potential for social desirability bias, and misinterpretation of questions resulting in misclassification). However, as noted above, recent biomarker testing of a sub-sample of ASH Year 10 participants indicated that the survey provides a valid population estimate of smoking prevalence (Sunseri & White 2017). The measure of past week exposure to smoking in the home was rather blunt (based on days per week exposed) and based on self-report rather than objective measures, and therefore may not have picked up important changes in intensity of exposure over time. We used school decile as a proxy for socio-economic status, since more direct measures were unavailable. Because school communities are heterogeneous, it is an imperfect measure at the individual level, and residual confounding by socio-economic status is possible in our adjusted analyses.

Our findings indicate that the remarkable decline in adolescent smoking in New Zealand since 2002 cannot be explained by declining exposure to parental smoking, sibling smoking or past

week exposure to smoking in the home. These factors have not contributed measurably to the trend, either individually or collectively. Best friend smoking was a very strong predictor of adolescent smoking and a significant contributor to the decline, raising the possibility of a self-perpetuating feedback loop, though this remains to be tested and cannot explain what initially triggered the decline. It is clear that factors other than those in our model are at play, with changes in the policy context and the price of tobacco potential contributors. Part 2 discusses these factors and tests the hypothesis that increasing tobacco prices have contributed to adolescent smoking decline.

Part 2: The role of tobacco price

Background

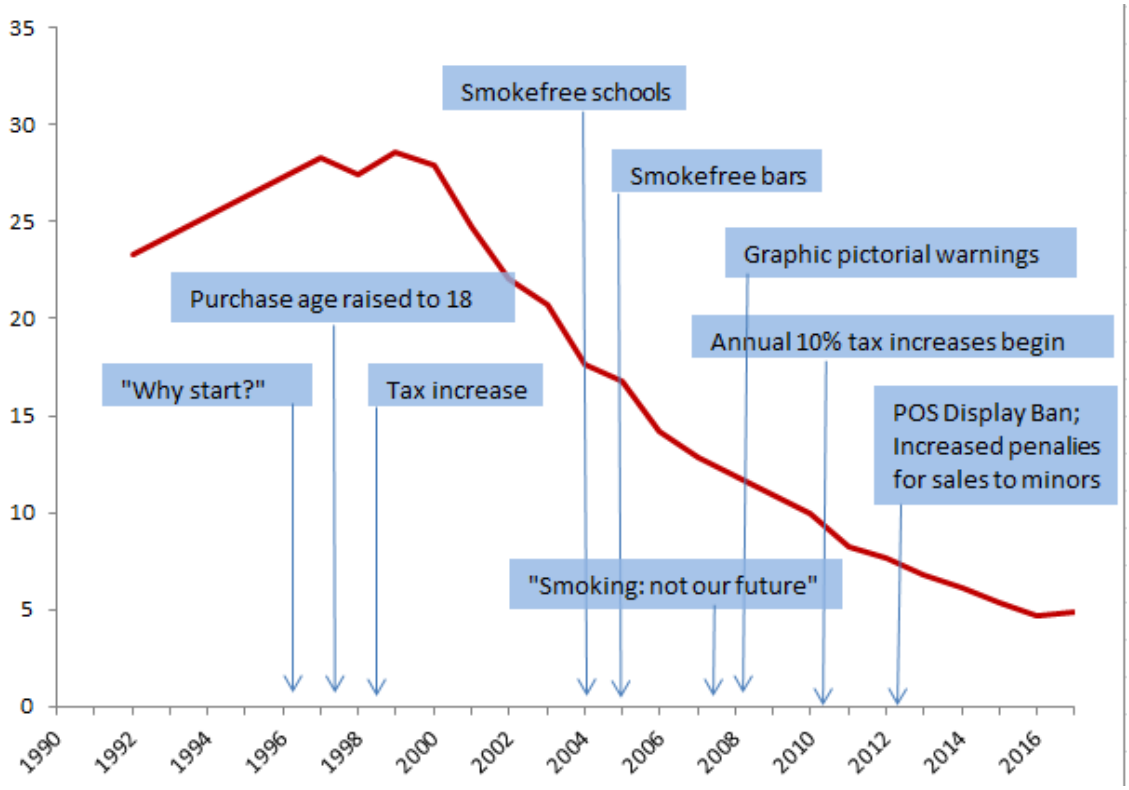
The Smoke-free Environments Act passed in 1990 was a tobacco control watershed in New Zealand, making the sale of tobacco products to adolescents aged under 16 illegal, placing restrictions on smoking in many indoor workplaces and banning smoking on public transport and certain other public places. It also made most forms of tobacco advertising and marketing illegal, leading to the phasing out of tobacco company sponsorship over the following five years (Thomson & Wilson 1997). Yet despite the strengthening of tobacco control efforts from 1990, adolescent smoking rose sharply during the 1990s in New Zealand, as it did in many other high income countries.

The international rise of adolescent smoking in the 1990s led to further policy responses such as tobacco tax rises and mass media campaigns in Australia, the UK, and the US, which, evidence suggests, met with some success in reducing adolescent smoking (Pampel & Aguilar 2008, White et al. 2011, White et al. 2015b). Could the same be true in New Zealand?

In New Zealand the policy responses to rising youth tobacco use in the 1990s included raising the legal age of tobacco purchase from 16 to 18 years of age in 1997; a 1998 tax increase which raised the price of a packet of 20 cigarettes by 13% (O'Dea & Thomson 2007) and the 'Why start?' mass media campaign which ran from 1996 to 1998 targeting young people. Tobacco control action continued in the early 21st century including ratification of the WHO Framework Convention on Tobacco Control and bans on smoking in schools, pubs and all other indoor workplaces implemented in 2004. This was accompanied by mass media campaigns about the effects of secondhand smoke (Edwards et al. 2008). Subsequently, the

'Smoking: Not our future' mass media campaign was launched in 2007 and aimed to denormalise smoking using youth role models including musicians and sportspeople (Fryer et al. 2008). Graphic pictorial warnings on tobacco products were introduced in 2008, and annual 10% increases in tobacco excise tax from 2010 led to sharply rising tobacco prices from that year. A point of sale display ban introduced in 2012 meant that retailers had to store tobacco products out of sight of customers, and in the same year penalties for selling tobacco to those aged under 18 years of age were increased, with both measures primarily aimed at preventing tobacco uptake in adolescents. The 'Stop before you start' mass media campaign, also aimed at prevention but targeting young adults, was launched in 2014. Figure 38 provides a timeline of key youth-relevant policy interventions, juxtaposed against adolescent smoking prevalence in New Zealand from 1990 – 2017.

Figure 38: Regular smoking prevalence (%) in Year 10 students and key policy interventions, 1990-2017



Tax is perhaps the most well-researched of tobacco control interventions and, internationally, there is consistent evidence that tobacco tax reduces tobacco consumption and smoking prevalence in *adults* (Chaloupka et al. 2012). Findings are mixed, however, on the effects of tobacco tax on *adolescents*. For example, as previously noted, Pampel and Aguilar examined

possible causes of fluctuations in smoking prevalence in high school seniors (aged 17-18) in the USA from the late 1970s to 2002 using time series analysis, and found that rising tobacco prices contributed to the decline from the late 1990s (Pampel & Aguilar 2008). However another study found that while older adolescents (aged 17-18) were highly price sensitive, price made an insignificant impact on smoking trends in 13-16 year olds in the US (Gruber 2000).

Many studies that have modelled smoking initiation (i.e. the probability of moving from being a non-smoker to a smoker over a given period) have found that tobacco price was not a significant determinant of smoking initiation (Bader et al. 2011). However, results are mixed, and one study that addressed some of the methodological limitations of earlier studies came to the opposite conclusion – that an increase in the price of cigarettes significantly reduced the number of adolescents that started smoking (Tauras et al. 2001).

More recently, speculating about the possible causes of US smoking decline in the 2015 Monitoring the Future overview report (which included students in Grade 8, 10 and 12), Johnston et al state:

> *In addition to changes in attitudes and beliefs about smoking, price almost surely also played an important role in the decline in use. Cigarette prices rose appreciably in the late 1990s and early 2000s as cigarette companies tried to cover the costs of the 1998 Master Settlement Agreement, and as many states increased excise taxes on cigarettes. A significant increase in the federal tobacco tax passed in 2009 may have contributed to the continuation of the decline in use since then (Johnston et al 2016, p7.)*

Note that Johnston et al did not empirically test the impact of tax increases, so this assertion is conjectural. Where the impact of tax increases on younger adolescents has been studied, the findings are equivocal. For example in Canada, Manivong et al concluded that increases in tobacco tax between 2002 and 2012 in some provinces did not contribute to the decline in smoking in adolescents aged 15 to 18 years over that period, since there was no significant difference in decline between provinces with and without tax rises. The authors noted, though, that tobacco taxation was already relatively high in all provinces at the beginning of the study period, and tax increases (where they were implemented) were modest – perhaps not large enough to make a measurable impact (Manivong et al. 2017).

Given the uncertain effects of tobacco tax on adolescent smoking initiation and prevalence, we set out to investigate the relationship between tobacco price and regular smoking in Year 10 students (aged 14-15) in the New Zealand context, 2002-2015, using an ecological approach.

Research questions

Looking separately at the periods before (2002-2010) and after (2010-2015) annual 10% tobacco tax increases were introduced, Part 2 addresses these questions:

- Was there an association between tobacco price and prevalence of regular smoking in Year 10 students?
- Did the slope of the decline in adolescent smoking change after the introduction of annual tax increases?

Methods

Data and variables

As for Part 1 (above), the outcome variable 'regular smoking' (Yes/No) was defined as smoking at least monthly, based on the question 'How often do you smoke now?' in the annual ASH Year 10 Snapshot Survey. For this ecological study, annual prevalence of regular smoking was the outcome of interest.

'Tobacco price' was the key predictor variable, and was based on the Cigarettes and Tobacco Price Index, available from Statistics New Zealand, indexed to the June 2006 quarter. The Consumer Price Index for all goods (also from Statistics New Zealand) was used to adjust the Cigarettes and Tobacco Price Index for inflation.

The other predictors were the demographic factors and risk factors outlined in Part 1, with the exclusion of 'best friend smokes', i.e. age, sex, ethnicity, school decile, both parents smoke, only father smokes, only mother smokes, older sibling smokes, past week exposure to smoking in the home, daily exposure to smoking in the home. Best friend smokes was not included in the ecological analysis because, as discussed above, respondents and their best friends were part of the same population, so it would be circular to include it as an ecological-level predictor. To convert individual risk factors to ecological variables, we used the

proportion exposed in each survey year. For the demographic factors, we used proportion aged 14, proportion male, proportion Māori, proportion Pacific, proportion Asian, proportion low decile, and proportion medium decile.

Analysis

First, we plotted inflation adjusted tobacco price and prevalence of Year 10 regular smoking (for the sample as whole, for Māori students, and by school decile), to illustrate changes in the price of tobacco over the study period against changes in adolescent smoking.

To determine the association between tobacco price and regular smoking in Year 10 students, standard forward stepwise regression was used to enable adjustment for the other predictors. This approach was used because, with only 11 data points (i.e. years), there were insufficient degrees of freedom to include all predictors in a fully adjusted model. To compare the periods before and after annual tax increases were introduced, we looked at the 2002-2010 and the 2010-2015 periods separately.

Initially, we allowed the stepwise procedure to choose the best predictor(s) from the demographic factors and risk factors. The procedure continues adding variables to the model until none of the remaining variables are statistically significant predictors of the outcome when added to the model. We then added tobacco price, to see whether this improved the fit of the model, and whether price was a significant predictor after adjustment for the best predictor(s) out of the other covariates.

Then, taking a different approach, we included price with the other predictors in a forward stepwise model, to see whether price was chosen as a key predictor.

Finally, we calculated the slope of the trend for regular smoking separately for the 2002-2010 (pre-tax increase) and the 2010-2015 (annual tax increase) periods using simple linear regression with year as the predictor. This allowed us to determine whether the decline in smoking accelerated following the introduction of annual tax increases. This analysis was completed for the sample as a whole, for Māori students, and by school decile.

Results

During the first part of the study period, 2002 to 2010, excise tax was adjusted each year for inflation but there were no above-inflation increases in tobacco tax. Therefore, as shown in Figure 39, the price of tobacco relative to other goods changed little over this period. During this stable price period, regular smoking in adolescents fell sharply from 22% to 10%. Among

Māori, smoking prevalence fell from 37% to 21%. As shown in Figure 40, adolescent smoking also fell sharply in students from all school deciles.

From 2010, tobacco excise tax was increased by 10% (plus inflation) each year, and because of the compounding effect of these tax increases, tobacco price rose sharply from 2010 to the end of the study period, 2015. During this period adolescent smoking prevalence continued to decline from 10% to 5% overall, and from 21% to 11% in Māori adolescents (Fig 29).

Figure 39: Inflation-adjusted tobacco price and prevalence of regular smoking in Year 10 students, overall and Māori, 2002-2015

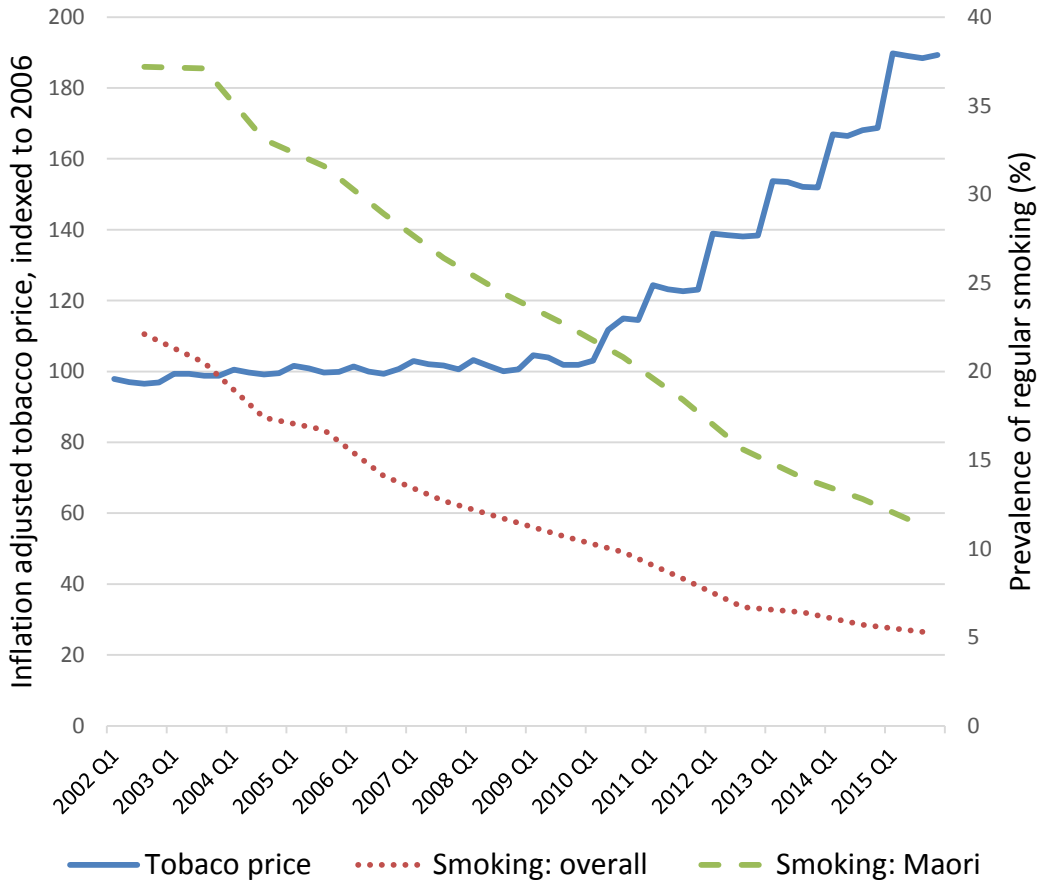
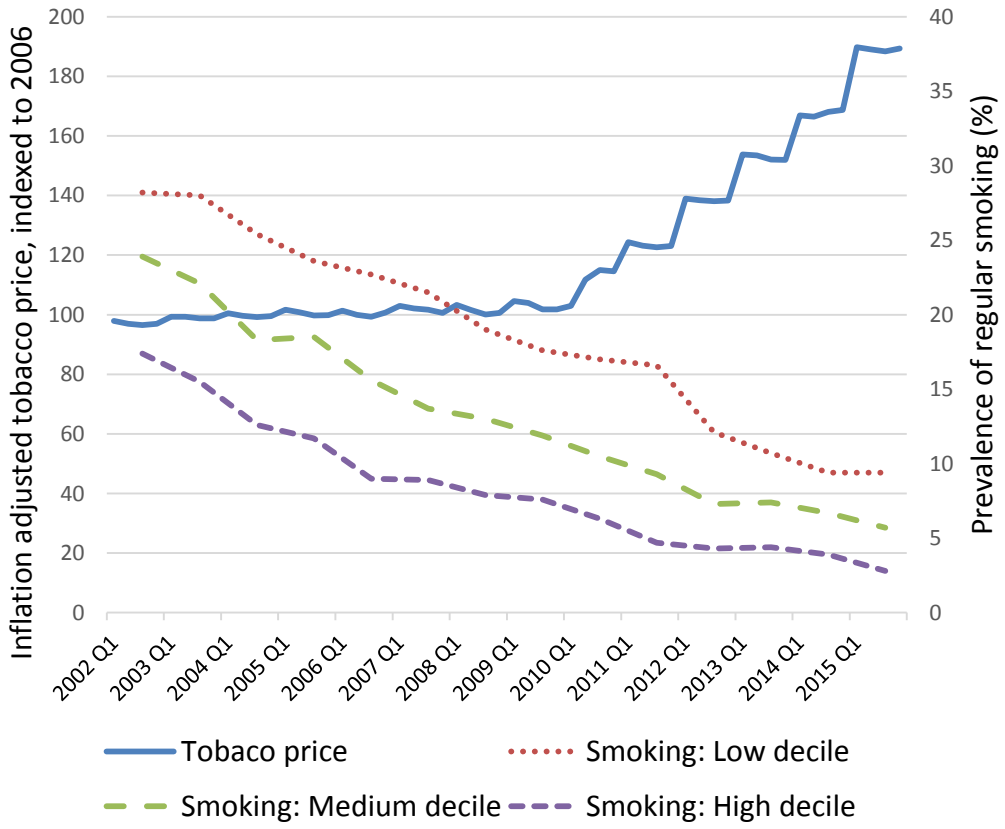


Figure 40: Inflation-adjusted tobacco price and prevalence of regular smoking in Year 10 students, by school decile, 2002-2015



Given that price changed little during the 2002-2010 period, while adolescent tobacco use fell rapidly, it seems very unlikely that price contributed to the decline in smoking prior to 2010. This is confirmed by the results of the stepwise regression (Table 19), which showed that price was *not* a significant predictor of regular smoking prevalence in the pre-tax increase period (2002-2010). The stepwise procedure selected 'prevalence of daily exposure to smoking in the home' as the best predictor. When tobacco price was added to the model, the fit of the model was not significantly improved ($p=0.339$ for difference in R^2) and tobacco price was not a significant predictor after adjusting for prevalence of daily exposure to smoking in the home.

Table 19: Results of stepwise regression investigating the relationship between tobacco price and prevalence of regular smoking, pre-tax-increase period (2002-2010)

Model	Variables entered	Coefficient	P value	R^2
1. Stepwise	Prevalence of daily exposure to smoking in the home	1.298	<0.001	0.986
2. Stepwise + tobacco price	Prevalence of daily exposure to smoking in the home	1.229	=0.001	0.990
	Tobacco price	-0.071	0.339	

However, the results shown in Table 20 suggest tobacco price *was* a significant predictor in the period of annual tax increases (2010-2015). 'Prevalence of maternal smoking' was selected by the stepwise procedure as the best predictor in this latter period. When tobacco price was added to the model, the fit of the model improved from $R^2 = 0.992$ to $R^2 = 0.999$ (p=0.028), and tobacco price was found to be a significant predictor after adjustment for prevalence of maternal smoking.

Table 20: Results of stepwise regression investigating the relationship between tobacco price and prevalence of regular smoking, period of annual tax increases (2010-2015)

Model	Variables entered	Coefficient	P value	R^2
1. Stepwise	Prevalence of maternal smoking	3.144	<0.000	0.992
2. Stepwise + tobacco price	Prevalence of maternal smoking	2.582	<0.000	0.999
	Tobacco price	-0.012	0.028	

Using an alternative approach, we repeated the stepwise regression, this time including tobacco price with the other predictors and allowing the stepwise process to choose the predictor(s) with the best fit. The results (not shown) were similar: for the pre-tax (2002-2010) period, tobacco price did not enter the model, and (after adjustment for the predictors that were entered: prevalence of paternal smoking, and proportion Asian) was not a significant predictor (p=0.57) of adolescent smoking. But in the period of annual tax increases (2010-2015), tobacco price (p<0.001) was the second predictor entered into the model after 'prevalence of maternal smoking' and improved the fit from $R^2 = 0.992$ to $R^2 = 0.999$ (p= 0.028).

These results indicate that, at the ecological level, the prevalence of adolescent smoking and tobacco price were not associated prior to 2010, but from 2010-2015 (after annual tax increases were introduced) there was a strong association after adjustment for the most predictive covariate. However this does not necessarily mean that increasing tobacco prices *caused* (or even necessarily contributed to) the decline in adolescent smoking from 2010. If

there was a causal relationship, we would expect that the slope of the decline in adolescent smoking to increase (i.e. become steeper) following the introduction of annual tax increases.

As shown in Table 21, for the sample as a whole, and for students from medium and high decile schools, there was actually a statistically significant *decrease* in the slope of the decline after the introduction of annual tax increases in 2010. Only among students from low decile schools was there a steeper slope during the period of annual tax increases, but the difference in the slopes between the two periods was not statistically significant.

Table 21: Slope of decline in adolescent smoking, before and after annual tax increases were introduced

		Slope	Difference	95% CI	Z statistic	p value
Whole sample	2002-2010	-1.509				
	2010-2015	-0.874	-0.635	(-1.04, -0.23)	-3.0686	p<.01
Māori students	2002-2010	-2.190				
	2010-2015	-1.883	-0.307	(-0.65, 0.04)	-1.7344	n.s.
Low decile	2002-2010	-1.565				
	2010-2015	-1.763	0.198	(-0.50, 0.89)	0.5595	n.s.
Medium decile	2002-2010	-1.653				
	2010-2015	-0.917	-0.736	(-1.10, -1.16)	-3.929	p<.001
High decile	2002-2010	-1.384				
	2010-2015	-0.574	-0.81	(-1.16, -0.46)	-4.5810	P<.001

Discussion

We found that tobacco price was stable between 2002 and 2010, a period when adolescent smoking declined steeply. This suggests that price was not an explanatory factor for the rapid decline in adolescent smoking in New Zealand in the first decade of the 21st century. Whether tobacco price contributed to the decline in adolescent smoking in the period from 2010 is not clear. Although tobacco price and prevalence of adolescent smoking were (negatively) correlated in the period after annual tax increases were introduced, rising tobacco prices did not result in a statistically significant acceleration of smoking decline in the 2010-15 period compared to 2002-2010. In fact smoking decline *decelerated* in the period from 2010, except among students from low decile schools. Although it is possible that adolescent smoking might have decelerated more strongly had tax increases not been introduced, the smooth decline over the study period as a whole tends to suggest that tax has had a minor role (if any) in the decline of Year 10 smoking in New Zealand.

It is notable that smoking declined steeply among students at low-decile schools from 2011, shortly after the introduction of annual tax increases. As a result of this acceleration, there was a significant narrowing of the gap in smoking prevalence between students from high and low decile schools between 2011 and 2015. International evidence suggests that low income communities are particularly price-sensitive (Bader et al. 2011, Chaloupka et al. 2012) so it is plausible that the tax increases from 2010 may have had a differential effect on students from low decile schools. This study provides ecological evidence that tax increases may have contributed to the narrowing of socio-economic disparities in adolescent smoking in the post-2010 period, though the temporal correspondence of ecological trends must be considered a weak and unreliable form of evidence (Kasl 1979, Kasl 1980, Morgenstern 1995), and it is difficult to explain why tax would have a two-year lag[15] rather than an immediate effect.

The findings of the current study are consistent with several international studies which also show that tobacco taxation has little impact on smoking initiation and prevalence in younger adolescents (Gruber 2000, Mayhew et al. 2000, Bader et al. 2011). The apparent ineffectiveness of tax rises on younger adolescents is likely to be because this age group typically accesses tobacco via friends and family rather than buying it themselves. For example a New Zealand study found that between 2006 and 2012, only 10-12% of Year 10 smokers reported that they 'usually' bought tobacco from a shop (Gendall et al. 2014). Although taxation may have little effect on initial experimentation with tobacco, this does not necessarily mean that tax is ineffective as a preventive measure. High tobacco prices are likely to prevent or delay the typical progression from occasional to established daily use entailing regular purchase of tobacco (Mayhew et al. 2000, Bader et al. 2011).

Given that tax does not appear to have contributed markedly to the decline in Year 10 smoking, then are other policy measures responsible for this major shift in youth behaviour? This is unknown, since the impact of other tobacco control policies in New Zealand on adolescent smoking have not been robustly evaluated, and it was not feasible to conduct such evaluation as part of the current study.

However, international studies have demonstrated that population-level interventions can influence adolescent smoking prevalence, though effect sizes are generally small. For

[15] Tax rises were implemented in April 2010 (before the 2010 Year 10 survey was in field) and in January of subsequent years. It was not until mid-2012 that a sharp drop in smoking was observed in students from low decile schools.

example, evaluations have shown that social marketing and mass media campaigns can have an impact on adolescent smoking at the population level (Farrelly et al. 2005, White et al. 2015b). Smokefree environments legislation has been associated with declines in adolescent smoking (Katikireddi et al. 2016), and declining exposure to second hand smoke in children and adolescents (Akhtar et al. 2007). Increasing the legal age of purchase was associated with a decline in adolescent smoking in England, and appeared to have similar effects in all socio-economic groups (Millett et al. 2011). However, in an international study comparing adolescent smoking rates in European countries that had introduced age restrictions with those that had not, no association was found (Kuipers et al. 2017). Point of sale (PoS) display bans have been widely introduced in recent years, and findings on their impact on adolescents appears to be mixed (Kuipers et al. 2016, Bogdanovica et al. 2017, Edwards et al. 2017). A quasi-experimental study using international comparison concluded:

> *The implementation of PoS display bans in Europe was associated with a stronger decrease in regular smoking among adolescents. This decrease does not appear to be driven by a decreasing accessibility of tobacco, but might be caused by further de-normalisation of tobacco as a result of PoS display bans (Van Hurck et al. 2018, p1).*

Van Hurck et al raise an important possibility that declining adolescent smoking may be less the result of specific tobacco control measures, and more to do with the denormalisation of smoking, with novel tobacco control measures and changing social attitudes playing a mutually reinforcing role in the denormalization process. This hypothesis is not new: Simon Chapman wrote an essay in 2003 critiquing attempts to explain (adult) smoking decline with reference to specific policy measures. He argued that 'On any given day…smokers are exposed to a welter of news, information, persuasion, and policies designed to turn them off smoking' and therefore:

> *[T]he ambition to attribute specific preventive or cessation effects to particular tobacco control interventions is highly problematic when there is interplay of continuous, uncontrolled, unmeasured, and sometimes unmeasurable variables intended to influence [tobacco] consumption' (Chapman 2003, p 429).*

However, if tobacco denormalisation explains the decline in adolescent smoking, is it simply a coincidence that adolescent alcohol use, teen pregnancy and juvenile crime have also declined over the same period? Or does this suggest there are additional overarching influences that are impacting on a range of adolescent risk-taking behaviours?

Conclusions

The findings of this chapter indicate that modest declines over time in parental and sibling smoking did not contribute to declining smoking in Year 10 students from 2003 to 2015, and nor did exposure to others' smoking in the home. The results of Part 1 suggest that if tobacco control measures have influenced adolescent smoking, it is not via these proximal factors. Nor does tobacco price appear to have played a significant role, certainly not in the first decade of the 21st century. It is possible that annual tax increases since 2010 may have contributed to ongoing declines in adolescent smoking, particularly among students in low decile schools, but the evidence is equivocal. On balance, it is likely that tobacco taxation has played a minor role, if any, in the decline of smoking in Year 10 students in New Zealand over the 2002-2015 period. Of the tobacco-specific factors tested, only best friend smoking significantly contributed to adolescent smoking trends. But since respondents and their best friends belong to the same population in which smoking is declining, this provides a somewhat circular explanation at the population level.

This study leaves much unknown about the drivers of smoking decline in the 14-15 age group, for example the possible roles of tobacco-related attitudes, denormalisation of smoking, and a peer feedback loop. Factors that have been shown to underlie risk behaviours as a whole, such as parental monitoring and attachment to family and school, may also be important determinants of smoking decline. There is potential to explore some of these remaining questions via analysis of other repeat cross-sectional data sets from New Zealand, for example, the Youth 2000 series. The subsequent chapters explore a range of potential explanatory factors, looking not only at adolescent smoking but also the three other outcomes of interest: binge drinking, cannabis use and underage sexual intercourse.

CHAPTER 6: PREDICTORS COMMON TO MANY RISK BEHAVIOURS

Introduction

The previous chapter focused on tobacco-specific predictors, and found that (with the possible exceptions of 'best friend smoking' and the impact of tobacco price rises since 2010 on students in low decile schools) none of those examined helped to account for the population-level decline in adolescent smoking in New Zealand in the early 21st century. Given that binge drinking, cannabis use and sexual behaviour have also declined, perhaps changes in individual level predictors common to *all four* risk behaviours are behind these concurrent trends.

This chapter tests this hypothesis using repeat cross-sectional data from the Youth 2000 National Youth Health and Wellbeing surveys undertaken in 2001, 2007, and 2012. The surveys were comprehensive, including many questions on contextual variables in home, school and leisure settings that could plausibly have changed over time, influencing risk behaviours.

As discussed in Chapter 2, there has been a great deal of research on risk and protective factors for substance use and early sexual initiation, and the evidence suggests strong commonality across countries with regard to important predictors (de Looze et al. 2015c). Key findings from the literature are highlighted briefly below, along with consideration of which predictors could be empirically explored using New Zealand's Youth 2000 data. Predictors are organised according to the three key settings in which adolescents spend the majority of their time: i) home, ii) school and iii) leisure.

Home setting

The home setting has many dimensions such as household socio-economic status, parenting style, parental modelling etc., many of which have been empirically associated with adolescent risk behaviour (Viner et al. 2012, Davids et al. 2017). Two key dimensions are parental monitoring and family connectedness.

Parental monitoring

Parental monitoring has been defined as 'a set of correlated parenting behaviours involving attention to and tracking of the child's whereabouts, activities, and adaptations' (Dishion &

McMahon 1998). In lay terms, it refers to the extent to which parents keep a close eye on their children, and overlaps with similar constructs such as 'family management' (Hawkins et al. 1992, Toumbourou et al. 2018b). In younger children, where such monitoring generally involves direct observation, researchers may use the term ' parental supervision' (Dishion & McMahon 1998). As young people gain independence, direct supervision is no longer possible or developmentally appropriate and therefore indicators of parental monitoring of adolescents generally focus on parental *knowledge* – or desire for knowledge - about where their offspring are and whom they are with. As noted by Stattin & Kerr, such knowledge is generally disclosed by the young person themselves, so 'parental monitoring' indicators may in fact be measuring parent-child communication or quality of the parent-child relationship, rather than parental tracking or surveillance (Stattin & Kerr 2000). That is, 'high parental monitoring' may indicate a warm and open parent-child relationship rather than 'strictness' on the part of parents, as the term might suggest. Indeed, an overly controlling or authoritarian parenting style is associated with *increased* likelihood of risk behaviour (Bronte-Tinkew et al. 2006, Newman et al. 2008).

Indicators of high parental monitoring are consistently associated with lower likelihood of substance use and underage sexual activity (Li et al. 2000, DiClemente et al. 2001, Ryan et al. 2010, Van Ryzin et al. 2012, Dittus et al. 2015, Yap et al. 2017), despite lack of standardised question wording. Furthermore, repeat cross-sectional data from many countries including England (Hagell 2012), Sweden (Larm et al. 2018), the USA (Grucza et al. 2016) and Finland (Raitasalo et al. 2018) suggest that parental monitoring – as assessed by adolescents – has increased over time. Has parental monitoring also increased in New Zealand, and, if so, has it contributed to the decline in risk behaviour observed since the turn of the century? The Youth 2000 survey includes a question on parental monitoring, allowing me to explore these questions.

Family connectedness

Family connectedness is a multi-dimensional construct encompassing family or parental closeness, support, warmth, responsiveness and/or involvement (Manzi & Brambilla 2014)**.** There is no universal definition for or standard measures of family connectedness, and a wide range of survey questions may be used as indicators of this construct. For example, questions about emotional bonds with parents, amount of time spent with family, the perceived quality of the relationship with parents/family, ease of communication with parents, or questions about who the respondent talks to when upset or faced with a problem may all be used as

indicators of family connectedness (Carter et al. 2007, Manzi & Brambilla 2014, Carver et al. 2016).

Family connectedness has been consistently shown to be protective against adolescent risk behaviour (Markham et al. 2003, Barnes et al. 2007, Carter et al. 2007, Viner et al. 2012, Davids et al. 2017), and a key asset enabling healthy development in young people who have experienced trauma or adversity (Fergus & Zimmerman 2005). Indicators from several countries suggest that teens' relationships with their parents have improved in recent years, characterised by less conflict (Twenge 2017), improved ease of communication (Brooks et al. 2015), greater likelihood of confiding in parents (UK Cabinet Office 2014), and easier communication with fathers (Stevens et al. 2018) for example. Is the same true in New Zealand? Youth 2000 includes a number of family connectedness indicators including questions about having fun as a family; maternal and paternal warmth; feelings of closeness to mother and father; and respondents' perceptions about whether family relationships are good or problematic.

School setting

The school setting, and the extent to which young people are engaged in school, has important implications for wellbeing and risk behaviour.

School connectedness

School connectedness is one of an array of overlapping constructs (others include school engagement, school attachment and school bonding) referring to a student's relationship to school. It is conceptualised and operationalised in different ways by different researchers but sense of belonging at school is a key indicator common to most (Libbey 2004). Students' liking for school, sense of teacher support, and sense that school rules are fair have also been used as indicators of school connectedness (Libbey 2004).

School climate

School climate has been defined as the 'quality and character of school life' (Cohen et al. 2009). When based on student reports, some indicators may be similar to those for school connectedness: sense of safety, belonging, support and fairness. Other indicators of school climate may include the degree to which students, teachers and staff contribute to decision making at the school; the quality of teaching; and teacher expectations of student achievement for example (Kohl et al. 2013).

Positive school climate and school connectedness are strongly associated with emotional wellbeing and positive academic outcomes, and have consistently been found to be protective against risk behaviour (Carter et al. 2007, Cohen et al. 2009, Jackson et al. 2012b, Viner et al. 2012, Cornell & Huang 2016). Based on this evidence, whole-school interventions to improve school climate and school connectedness have been a key strategy to improve student outcomes in high-income countries in recent decades (Viner et al. 2012, Shackleton et al. 2016). For example, the World Health Organisation developed the Health Promoting Schools programme in the late 1980s, and by 2009, 67% of New Zealand schools were part of the programme (Ministry of Health 2012).

Over the same period, pedagogical and cultural changes have led schools to become more student-centred and less authoritarian (e.g. corporal punishment was outlawed in New Zealand schools in 1986). Could increasing school connectedness have contributed to declining risk behaviour among New Zealand adolescents? The Youth 2000 survey asks whether respondents feel part of school, whether students are treated fairly by teachers, and whether teachers have high expectations of student achievement. Based on these indicators, it is possible to investigate whether school connectedness has improved, and whether this has contributed to the decline in risk behaviour.

At the national level, access to education is strongly linked to adolescent wellbeing. Research shows that, globally, higher secondary school completion rates are associated with lower rates of adolescent pregnancy (Bongaarts et al. 2017) and improved health and social outcomes (Viner et al. 2012). Within country studies have also demonstrated that rising educational participation by young women has led to delayed fertility (Ni Bhrolchain & Beaujouan 2012, Girma & Paton 2015). At the individual level, academic aspirations and achievement are negatively correlated with risk behaviours (Tyas & Pederson 1998), but whether rising educational participation is an explanatory factor for declining prevalence of adolescent risk behaviours at the population level is not established.

Data from all countries of interest show that school completion rates have increased over the study period at the national level. Is this reflected in New Zealand students' school leaving intentions, and are school leaving intentions associated with risk behaviour at the individual level? Is the proportion planning tertiary study increasing over time, and is this associated with the decline in risk behaviour? Youth 2000 data allows us to explore all these questions.

Leisure time

How adolescents spend their discretionary time has a strong bearing on whether or not they become engaged in substance use and sexual risk behaviour.

Time with peers

Healthy adolescent development is characterised, in part, by increasing independence from parents and greater involvement with and attachment to friends (DiClemente et al. 2013). However there is consistent evidence of a positive association between time spent with peers, in particular unsupervised time in the evening, and engagement in risk behaviours and delinquency (Osgood & Anderson 2004, Barnes et al. 2007, Kokkevi et al. 2007, de Looze et al. 2015c, Hale & Viner 2016). For example, in the ESPAD study, the strongest risk factor for substance use (by a wide margin) was 'going out every night' (The ESPAD Group 2016).

As discussed in Chapter 4, there is international evidence that adolescents are spending less face to face time with their friends, and this may be an explanatory factor for the decline in risk behaviour. For example HBSC findings show that the proportion of 11-15 year olds in daily face to face contact with peers in the evenings declined in most high-income countries between 2002 and 2010 (de Looze et al. 2019), and initial analysis of ESPAD trends show 15-16 year olds in Europe have been going out less frequently since 2008 (personal communication from Karin Monshouwer, 21/09/18). US data also show that the proportion of adolescents regularly engaging in in-person social activities (e.g. getting together with friends after school, dating, or hanging out with friends at the mall) has declined since 2000 (Twenge 2017). New Zealand's Youth 2000 survey asks how much time the respondent spends hanging out with friends on a typical day (though where and when they hang out was not asked, nor whether there were adults present or not). This variable is only available for 2007 and 2012. Thus, it is possible to determine whether in-person socialising has declined in New Zealand over this period, as it has in many other high-income countries, and whether this has contributed to declines in the risk behaviours of interest.

Perhaps the most popular hypothesis for the decline of adolescent risk behaviours is that social media (or digital media more broadly) has displaced risk behaviour via a decline in in-person socialising (Twenge 2017, Arnett 2018). I am not able to test the influence of digital media use on in-person socialising, since comparable measures of digital media use are not available for the three survey years. However, I can test the second half of the hypothesised causal pathway: a decline in 'time spent with friends' leading to a decline in risk behaviours. It

must be noted, however, that other social changes may also have contributed to adolescents spending less time face to face with their friends, including, for example, increased parental monitoring, and decreased participation in part time work and therefore less financial independence.

Paid work

From a developmental perspective, engaging in paid part time work has obvious benefits for secondary school students, helping them to develop useful life skills and independence (Mortimer 2010). However, having a part time job is consistently associated with elevated likelihood of tobacco and alcohol use and other problem behaviours in teens (Darling et al. 2006, Mortimer 2010, Lee et al. 2017, Lintonen & Nevalainen 2017). There are a number of possible causal pathways that might explain this association. Firstly, teens who work for pay are likely to have more money to spend on cigarettes, alcohol and/or illicit drugs and more financial independence than those who only receive money in the form of an allowance. Secondly, since work is an adult-like social role, it is possible that teens with part time jobs may consider themselves mature and ready for other perceived adult-like behaviours (including substance use and sexual intercourse, for example). Thirdly, part time work may bring adolescents into contact with older teens and young adults, potentially influencing their behaviour via role modelling and/or workplace rituals (e.g. 'smoko'[16] or after-work drinks) and/or social supply of tobacco, alcohol or drugs. Work may also be a setting for meeting potential sexual partners. Existing Youth 2000 analyses show that the proportion of secondary school students in paid work in New Zealand fell sharply between 2001 and 2012 (Adolescent Health Research Group 2013), and Twenge demonstrates (using MTF data) that the same is true in the USA (Twenge 2017). Could this structural change be a contributor to the decline in risk behaviour?

Research questions

For each predictor of interest my research questions were:

- Is there an association between *predictor x* and smoking, binge drinking, cannabis use and/or sexual activity in New Zealand secondary school students aged under 16?
- Has exposure to *predictor x* changed over the course of the study period (in the expected direction) in this population?

[16] 'Smoko' is an informal term used in New Zealand and Australia to describe a short break from work, for smoking and refreshments.

- To what extent does *predictor x* account for trends in smoking, binge drinking, cannabis use and/or sexual activity in this population?

Methods

Survey methods and data

This study uses repeat cross-sectional data from the Youth 2000 National Youth Health and Wellbeing surveys undertaken in 2001 (N= 9,567), 2007 (N=9,107), and 2012 (N=8,500). These are nationally representative surveys of secondary school students in New Zealand, carried out by the Adolescent Health Research Group at the University of Auckland.

Each survey used a two-stage sample cluster design to ensure a nationally representative sample of secondary school students was recruited. Secondary schools were randomly selected, and invited to participate. School response rates were 84% in 2001, 86% in 2007 and 73% in 2012. Within participating schools, a random selection of students was invited to participate, with student response rates of 75% in 2001, 74% in 2007 and 68% in 2012 (Adolescent Health Research Group 2013).

The survey was designed to be 'youth friendly' and suitable for those with low literacy. It was administered using a multimedia computer-assisted self-administration interview (M-CASI), with each question read out over headphones as well as appearing in written form on the screen. From 2007, the questionnaire was translated into Māori (New Zealand's indigenous language), and participants had the option of using English or Māori. Responses were given by 'pointing and clicking'; keyboard data entry was not required. M-CASI has been shown to enhance perceptions of privacy and confidentiality and is associated with increased reporting of sensitive behaviours in comparison with paper-based questionnaires or interviewer-administered surveys (Watson et al. 2001).

Further details on Youth 2000 survey methods and characteristics of participating schools and students are available elsewhere (Adolescent Health Research Group 2013, Clark et al. 2013).

Participants

As noted in the introduction, my thesis focuses on younger adolescents because early engagement in risk behaviour is associated with greater risk of long term harm, and because school-based samples are not representative of the general adolescent population beyond the school leaving age, which is 16 in New Zealand. Therefore analysis in this study was restricted

to students under 16 years of age. Approximately 98% of this group were aged 13-15 years, with the remainder aged 11 or 12. For simplicity of analysis and reporting, those aged under 13 were grouped with the 13 year olds.

The demographic characteristics of the included sample, by year, are presented in Table 22. Note that in this table, and throughout discussion of Youth 2000 findings, proportions are adjusted for weighting and clustering in the complex sample design.

Table 22: Youth 2000 participant characteristics, by year (sample aged <16)

		2001		**2007**		**2012**	
		n	**%**	**n**	**%**	**n**	**%**
Total		6513	100	5934	100	5489	100
Sex	**Male**	3022	46.9	3252	54.9	2536	46.2
	Female	3491	53.1	2680	45.1	2952	53.8
Age	**13 or under**	2050	31.9	1860	31.2	1838	33.5
	14	2285	34.8	2101	35.4	1896	34.5
	15	2178	33.3	1973	33.4	1755	32.0
Ethnicity	**Euro/ Other**	3729	57.5	3478	58.6	2893	52.7
	Māori	1777	27.3	1235	20.8	1202	21.9
	Pacific	525	8.4	610	10.4	803	14.8
	Asian	391	6.8	595	10.1	581	10.7
School Decile	**High**	2269	33.1	1922	33.7	2090	38.1
	Med	3177	50.8	2959	51.2	2174	39.8
	Low	1067	16.1	871	15.1	1225	22.1
NZ Dep	**Least dep**	-	-	2042	35.4	1510	28.1
	Med	-	-	2206	38.1	2022	37.6
	Most dep	-	-	1533	26.5	1847	34.3
Locale	**Urban**	-	-	4864	84.3	4593	84.9
	Rural	-	-	919	15.7	834	15.1

Variables

Demographic variables

Age

This was based on the question 'How old are you?' (2012) or 'What age are you?' (2001, 2007) and responses were grouped into three categories: 13 and under, 14, 15.

Sex

Sex was based on the question 'What sex are you?' Answer categories were Male and Female.

School decile

School decile is a school-level measure of the socio-economic status of the school community, and is assessed by the Ministry of Education for funding allocation purposes. Each participant from the same school was assigned the same school decile score, with 1 representing most deprived and 10 representing least deprived. Further details about school decile were provided in the previous chapter.

Ethnicity

This was based on the question 'Which ethnic group do you belong to?' Participants selected as many answer options as were relevant, but for the purposes of the study, ethnicity was prioritised (i.e. each individual was assigned to only one ethnic group) using the Ministry of Health prioritisation hierarchy: Māori > Pacific > Asian > Other > European. Initial analysis showed findings for 'Other' were similar to those for 'European', so these groups were combined to simplify reporting.

Outcome variables

The outcomes of interest were past month smoking, past month use of cannabis, past month binge drinking, and sexual activity (i.e. intercourse) in the past three months. As discussed in Chapters 1 and 2, these are all behaviours that are considered problematic from a health perspective when engaged in by adolescents aged 13-15, and are (or at least *were*) relatively common and therefore relevant for population health. De Looze argues they are 'adult-like behaviours that take place in similar settings (i.e. in the peer context during leisure activities) and that have a similar symbolic function in adolescents' transition to adulthood' p19 (de Looze 2013). Details of how these outcomes were measured are provided below.

Smoking

Past month tobacco smoking was based on two questions: 'Have you ever smoked a whole cigarette?' and 'How often do you smoke cigarettes now?' with the second question only asked of those who answered 'Yes' to the first. The answer options were collapsed into two categories: 'No' ('No' to the first question, or 'Never – I don't smoke now' or 'Occasionally' to the second question) and 'Yes' ('Once or twice a month'; 'Once or twice a week'; 'Most days'; or 'Daily' to the second question).

Cannabis

Past month cannabis use was based on two questions: 'Have you ever smoked marijuana (pot, grass, weed, cannabis)?' and 'In the last 4 weeks, about how often did you smoke marijuana?' with the second question only asked of those who answered 'Yes' to the first. The answer options were collapsed into two categories: 'No' ('No' to the ever use question or ' Not at all - I don't smoke marijuana anymore' or 'None in the last 4 weeks' to the last 4 weeks question) and 'Yes' ('Once in the last 4 weeks'; 'Two or three times in the last 4 weeks'; 'Once a week'; 'Several times a week'; 'Every day'; or 'Several times a day').

Binge drinking

Past month binge drinking was based on two questions: 'We would now like to now ask some questions about alcohol. By this we mean beer, wine, spirits, pre-mixed drinks. Have you ever drunk alcohol (not counting a few sips)?' and 'In the past 4 weeks, how many times did you have 5 or more alcoholic drinks in one session - within 4 hours?' The answer options were collapsed into two categories: 'No' ('No' to the first question or ' None at all' to the second) and 'Yes' ('Once in the last 4 weeks'; 'Two or three times in the last 4 weeks'; 'Every week'; 'Several times a week').

Sexual activity

Sexual activity was defined as having sexual intercourse at least once in the past 3 months. In 2001 it was based on two questions: 'About how old were you when you first had an experience of sex? (By this we mean sexual intercourse or going all the way),' and 'In the last 3 months, how many people have you had sex with?' The second question was not asked of those who responded 'Never' to the first. Based on these questions, respondents were grouped into two categories: 'Not sexually active' ('Never' to the first question, or 'I have not had sex in the past three months' to the second), and 'Sexually active' (reported experience of sexual intercourse at any age, and reported one or more sexual partner(s) in the past three months).

In 2007, a question about sexual activity in the past year was added ('In the last year, who have you had sex with (sexual intercourse or going all the way)? Do not include sexual abuse or sex you did not want. You may choose more than one.') 'I have not had sex in the last 12 months' was included as an answer option. This question was only asked of those who reported experience of sexual intercourse at any age. Only those reporting having sex in the past year were asked about sexual activity in the past three months. Unlike 2001, the past three months question explicitly excluded sexual abuse or unwanted sex. Based on these questions, respondents were grouped into two categories: 'Not sexually active' ('Never', or 'I have not had sex in the last 12 months' or 'I have not had sex in the past three months'); and 'Sexually active' (reported experience of sexual intercourse at any age, and reported one or more sexual partner(s) in the past three months).

In 2012, sexual activity was based on two questions: 'Have you ever had sex? (by this we mean sexual intercourse). Do not include sexual abuse', and 'In the last 3 months, how many partners have you had sex with? Do not include sexual abuse or sex that you did not want.' The second question was not asked of those who responded 'No' to the first. Based on these questions, respondents were grouped into two categories: 'Not sexually active' ('No' to the first question, or 'I have not had sex in the past three months' to the second), and 'Sexually active' (responded 'Yes' to the first question and reported one or more sexual partner(s) in the past three months).

Predictor variables

Home factors

These were:

- parental monitoring
- fun with family
- relationship with family
- maternal/paternal closeness
- maternal/paternal warmth.

Parental monitoring was based on the question 'Does your family want to know who you are with and where you are?' Response categories in 2012 and 2007 were: 'Always' 'Usually' 'Sometimes' and 'Almost never'. In 2001 they were 'Always', 'Usually' 'Sometimes' 'Hardly ever' and 'Never'. For consistency across years responses were grouped into three categories: 1) High: 'Always', 2) Medium: 'Usually' and 3) Low: 'Sometimes' or 'Almost never' (2001 –

'Sometimes' 'Hardly ever', 'Never'). Note that in all three survey years more than 80% of respondents answered either 'Always' or 'Usually'.

Fun with family was based on the question 'How much do you and your family have fun together?' There were four response categories, however 2001 categories ('Not at all' 'A little' 'Some' 'A lot' differed in wording and order from 2007 and 2012 categories ('A lot' 'Often' 'Some' 'Not at all'). Recognising that there was no way of making the categories perfectly comparable across years, responses were grouped into three categories 1) 'A lot' (same wording all three years) 2) Sometimes (2007, 2012: 'Often' or 'Sometimes'; 2001 'A little' or 'Some') 3)'Not at all' (same wording all three years).

Relationship with family was based on the question 'Not getting on well with people in your family can make life difficult. How do you view your relationships with your family?' Response options were identical for all three survey years: 1) Happy – 'I'm happy about how we get on'; 2) Neutral – 'My family relationships are neither good nor bad'; 3) Problematic – 'Getting on with my family is causing me problems.'

Maternal and paternal closeness are two separate variables based on separate questions for mother and father (worded similarly): 'We now have some questions about your relationship with your mum/dad or the person who acts as your mum/dad. If there is no such person use the 'does not apply to me' option. How much of the time do you feel close to your mum?' Answer categories have been consistent across survey years: 1) Most of the time, 2) Sometimes, 3) Hardly ever.

Maternal/paternal warmth are two separate variables based on separate questions for mother and father (worded similarly) that follow on from the question above: 'How much of the time is your mum/dad warm and loving towards you?' Answer categories have been consistent across survey years: 1) Most of the time, 2) Sometimes, 3) Hardly ever.

School factors

These were:

- students treated fairly
- belonging at school
- school expectations
- intention to complete school
- plans after leaving school.

Students treated fairly was based on the question 'How often do the teachers at your school treat students fairly?' with answer categories identical across years: 1) Most of the time, 2) Sometimes, 3) Hardly ever.

Belonging at school was based on the question 'Do you feel like you are part of your school?' with answer categories 'Yes' and 'No'.

School expectations was based on the question 'Do people at your school expect you to do well?' with answer categories 'Yes' and 'No'.

Intention to complete school was based on the question 'What do you think will be the last year (or form) at secondary school for you?' with answers grouped into two categories: Yes ('Year 13') and No (Year 9, 10, 11, or 12).

Plans after leaving school was based on the question 'What do you plan to do when you leave secondary school?' Answer categories were 1) Get more training or education, 2) Start work or look for a job, 3) Start a family, 4) Do nothing. In 2012 additional answer categories were added, and these were merged with existing categories where possible. 'Go overseas to study' was combined with 'Get more training or education'; 'Go overseas to work' was combined with 'Start work or look for a job.' The other additional answer category 'Go back to my country of birth' was not compatible with any of the 2001/07 categories and was chosen by less than 1% of 2012 respondents (n=51), so was excluded from the analysis for this variable.

Leisure factors

These were:

- part time job
- time hanging out with friends.

Part time job was based on the (2001) question 'Do you have a regular part time job or jobs?' with answer categories 'Yes' or 'No'. In 2007 and 2012 the question was worded differently and had a range of answer categories: 'In the last year, have you worked for money or had a paid job (not including helping around your own home)?' 'Yes, a regular part time job e.g. a paper run'; 'Yes, I worked during the school holidays', 'Yes, I sometimes worked during the school term' and 'No, I didn't work for pay in the last year'. For consistency with 2001, only 'Yes, a regular part time job' was coded 'Yes' and all other responses were coded 'No' for the main analysis.

Additionally, for 2007 and 2012, work was re-coded to include all the work types included in the 2007 and 2012 question.

Time hanging out with friends was based on the question 'How much time do you spend doing these activities every day?' 'Hang out with friends' was one of 12 sub-questions, with answer options 1) None, 2) Less than 1 hour, 3) 1 to 2 hours, 4) 3 to 4 hours, 5) 5 hours or more.

Analysis

First, descriptive statistics were used to calculate the proportion of students who reported engaging in each outcome of interest (smoking, binge drinking, cannabis use and sexual activity), by survey year. Prevalence in each survey year by age, sex, ethnicity and school decile were calculated. I also investigated the number of risk behaviours each participant reported, calculating the proportion reporting 0, 1, 2, 3 and 4 of the outcomes of interest in each survey year.

Then, to confirm that the predictors identified in the international literature were associated with the outcomes of interest in this population, bivariate associations between each predictor and each outcome were calculated using logistic regression. Analysis was based on pooled (2001-2012) data and all models were adjusted for age, sex, school decile and ethnicity. Results were expressed as odds ratios (OR) and 95% confidence intervals (CI).

Next, trends in exposure to each predictor were explored using descriptive statistics to calculate the proportion exposed in each survey year.

Finally trend analysis based on individual-level data was conducted using logistic regression. To test the extent to which each predictor accounted for changes over time in the outcomes of interest, I modelled each outcome (smoking, cannabis use, binge drinking and sexual activity) as a function of survey year, adjusting for demographic factors (age, sex, ethnicity and school decile), and including school ID as a random effect to account for clustering at the school level. This was Model 1 – the base model, showing the likelihood of each outcome in 2007 and 2012 compared to the reference year, 2001. I then added each predictor to Model 1 in turn. Attenuation of the OR for year would indicate that the predictor partially accounted for the trend over time. Statistical significance of the attenuation was tested using Z tests to compare log odds.

Because 'time hanging out with friends' was not available in 2001, this variable was excluded from the trend analysis above. An additional trend analysis was conducted including 'Time

hanging out with friends' for the 2007 to 2012 period only. The method was the same as described above, but with 2007 as the reference year (Model 2).

To investigate the collective contribution of the predictors, they were then entered into the model collectively. Because the aim of the study was to identify factors that have contributed to the decline in adolescent risk behaviour, I included only those predictors that attenuated the OR for year (for one or more outcome), however slightly, in the individual models above. These were named 'contributing factors'.

All analyses were adjusted for the weighting and clustering in the complex sampling design, and were conducted using Version 9.4 of the SAS system for Windows.

As shown in Table 23, missing data was minimal for demographic variables, home factors and school factors. While there was a moderate amount of missing data (5%-7%) for 'Part time job' and 'Time hanging out with friends', there was little variation in the proportion missing between years. Therefore missing data for the predictors was considered to be ignorable, since it was not likely to impact on time trends, which are the focus of this study.

However missing data for the outcome variables was potentially more problematic, because the quantity of missing data was greater overall (8%-11%) and differed markedly between years, and therefore had the potential to distort trends. Some participants probably wanted to conceal their substance use or sexual behaviour, so respondents' risk behaviour engagement was likely to be a determinant of whether or not they answered these questions. Therefore we cannot reasonably assume that these missing data are 'missing at random' i.e. explainable by variables on which we have full data. In this situation, use of imputation is not appropriate since it can introduce bias (Bennett 2001). Instead, I conducted sensitivity analyses to test whether the findings of the main analyses were robust to a range of assumptions. These sensitivity analyses are presented in Appendix B.

Table 23: Missing data for each variable (sample aged <16)

	Missing 2001 (%)	Missing 2007 (%)	Missing 2012 (%)	Missing TOTAL	
Demographic variables				**N**	**%**
Age#	0.22	0.08	0.13	39	0.14
Sex	0.02	0.15	0.04	3	0.02
School decile	0.0	3.06	0.0	182	1.01
Ethnicity	1.45	0.39	0.18	117	0.65
Outcome variables					
Past month smoking	9.52	9.46	3.67	1367	7.62
Past month cannabis use	13.51	14.63	4.85	1974	11.01
Past month binge drinking	12.27	10.23	4.11	1612	8.99
Sexually active	7.33	15.65	3.29	1574	8.78
Home factors					
Parental monitoring	1.53	1.60	0.07	182	1.01
Fun with family	2.19	1.33	0.11	211	1.18
Relationship with family	2.71	1.58	0.13	257	1.43
Maternal warmth	1.90	1.85	0.15	224	1.25
Paternal warmth	2.85	1.82	0.36	294	1.64
Maternal closeness	2.02	1.63	0.15	219	1.22
Paternal closeness	2.71	1.80	0.27	281	1.56
School factors					
Students are treated fairly	2.25	1.95	0.24	258	1.44
Belonging at school	2.79	1.95	0.24	293	1.63
School expectations	3.28	2.02	0.42	339	1.89
Intention to complete school	2.62	2.10	0.45	301	1.68
Plans after leaving school	2.54	2.14	1.35	348	1.94
Time, money & friends					
Part time job	5.79	6.43	4.33	1407	5.18
Time hanging out with friends	-	7.25	5.09	703	6.15

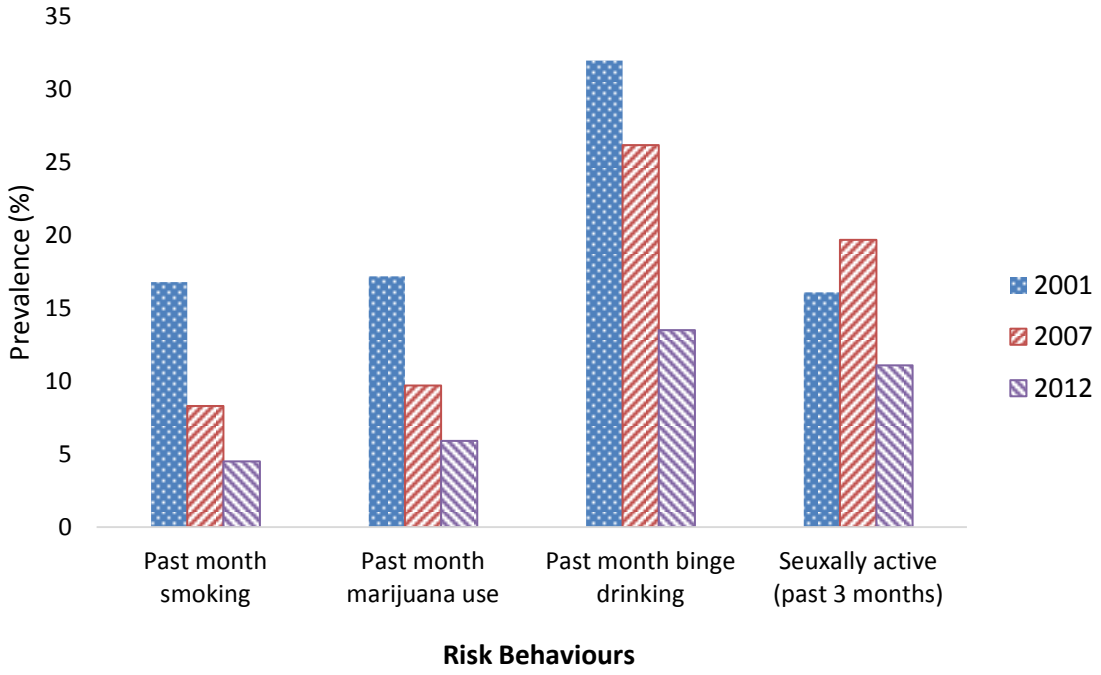
#Denominator = full sample rather than 13-15 year olds (where age is known for all, by definition)

Results

Prevalence of risk behaviours by year

Prevalence of all four outcomes of interest (past month smoking, past month cannabis use, past month binge drinking and sexually active in the past three months) declined substantially between 2001 and 2012 (Figure 41). All of the substance use variables declined in both the 2001-2007 and 2007-2012 periods, whereas the proportion that were sexually active increased between 2001 and 2007 before declining markedly between 2007 and 2012.

Figure 41: Prevalence of risk behaviours in secondary students aged <16 years, 2001-2012



The magnitude of the changes between 2001 and 2012 are striking, particularly for substance use. For example, whereas about a third of students were binge drinkers in 2001, this had fallen to less than one in seven by 2012. About one in six were smokers in 2001, falling to less than one in 20 by 2012. Such dramatic shifts in behaviour in such a short period are unusual. As shown in Table 24, declines occurred in all main demographic groups by sex, school decile and ethnicity. Sensitivity analysis demonstrated that these trends were robust to even extreme assumptions about item non-response (i.e. that *all* non-responders did or *all* did not engage in each risk behaviour). Non-response was greater in 2001 and 2007 than in 2012 (Table 23), and (as established in Appendix B) it is reasonable to assume non-responders were more likely to engage in risk behaviour than responders based on their demographic profile. Therefore the declines between 2007 and 2012 are likely to be underestimated and the 'true' magnitude of the decline in risk behaviours is likely to be even greater than that shown in Figure 41 and Table 24.

Table 24: Prevalence of risk behaviours in secondary students aged < 16 years, 2001-2012

		2001	2007	2012
Past month smoking	**Total**	**16.9 (15.2, 18.5)**	**8.3 (7.1, 9.4)**	**4.5 (3.8, 5.3)**
	Male	13.6 (11.8, 15.3)	6.3 (5.2, 7.3)	3.8 (3.1, 4.5)
	Female	19.6 (17.4, 21.8)	10.6 (8.7, 12.5)	5.1 (4.0, 6.2)
	Low decile	24.8 (22.9, 26.6)	12.3 (9.2, 15.3)	7.6 (5.3, 9.8)
	Medium decile	15.8 (13.5, 18.1)	8.8 (7.2, 10.3)	4.7 (3.8, 5.6)
	High decile	15.1 (12.6, 17.5)	6.3 (4.8, 7.8)	2.7 (2.0, 3.4)
	Asian	5.9 (2.4, 9.4)	1.5 (0.4, 2.7)	0.9 (0.0, 1.8)
	NZEO	13.1 (11.7, 14.5)	6.3 (5.3, 7.3)	3.2 (2.5, 4.0)
	Māori	27.1 (24.4, 29.8)	17.4 (14.5, 20.3)	8.7 (6.8, 10.6)
	Pacific	21.4 (17.5, 25.2)	8.0 (6.0, 10.1)	5.6 (3.8, 7.4)
Past month cannabis use	**Total**	**17.2 (15.4, 19.0)**	**9.7 (8.6, 10.8)**	**5.9 (5.0, 6.8)**
	Male	18.1 (15.7, 20.5)	10.5 (9.1, 11.9)	6.7 (5.4, 8.0)
	Female	16.4 (14.4, 18.5)	8.8 (7.2, 10.3)	5.1 (4.1, 6.2)
	Low decile	26.3 (22.5, 30.1)	12.2 (8.6, 15.9)	7.1 (5.5, 8.7)
	Medium decile	16.8 (14.1, 19.5)	10.0 (8.4, 11.5)	7.1 (5.3, 8.8)
	High decile	14.1 (11.5, 16.8)	8.8 (7.1, 10.6)	4.1 (3.1, 5.0)
	Asian	4.1 (0.9, 7.3)	3.1 (1.6, 4.5)	0.9 (0.2, 1.6)
	NZEO	12.8 (11.3, 14.4)	8.0 (6.9, 9.0)	4.9 (3.8, 5.9)
	Māori	31.2 (28.5, 33.9)	19.3 (16.3, 22.3)	11.7 (9.6, 13.8)
	Pacific	15.8 (11.1, 20.4)	7.7 (5.6, 9.9)	4.7 (3.2, 6.2)
Past month binge drinking	**Total**	**32.0 (29.3, 34.7)**	**26.2 (23.9, 28.5)**	**13.5 (12.0, 15.0)**
	Male	32.7 (29.3, 36.1)	26.2 (23.4, 29.0)	12.8 (10.5, 15.1)
	Female	31.4 (28.6, 34.1)	26.1 (23.1, 29.1)	14.1 (12.4, 15.7)

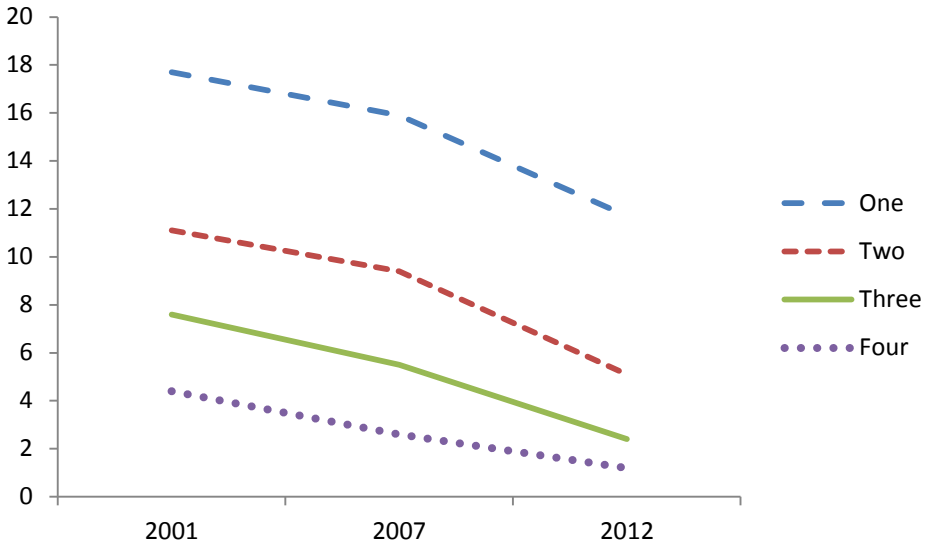
		2001	2007	2012
	Low decile	36.7 (31.2, 42.2)	30.4 (24.5, 36.3)	16.5 (13.1, 19.9)
	Medium decile	32.1 (27.3, 37.0)	28.6 (25.2, 31.9)	14.7 (12.0, 17.4)
	High decile	29.8 (27.6, 32.1)	22.2 (19.0, 25.4)	10.7 (8.8, 12.6)
	Asian	10.4 (4.0, 16.7)	9.0 (6.2, 11.7)	3.5 (2.0, 5.0)
	NZEO	29.7 (27.6, 31.8)	24.0 (22.2, 25.8)	12.3 (10.8, 13.8)
	Māori	45.3 (42.9, 47.7)	44.1 (41.0, 47.3)	23.4 (20.5, 26.2)
	Pacific	22.0 (17.8, 26.2)	20.1 (15.7, 24.6)	10.5 (8.3, 12.8)
Sexually active	**Total**	**16.1 (14.5, 17.8)**	**19.7 (18.0, 21.5)**	**11.1 (9.7, 12.5)**
	Male	16.7 (14.5, 18.9)	21.0 (18.7, 23.2)	11.4 (9.5, 13.3)
	Female	15.6 (13.8, 17.4)	18.3 (15.9, 20.7)	10.9 (9.2, 12.6)
	Low decile	28.6 (25.9, 31.3)	28.1 (23.6, 32.7)	17.3 (14.3, 20.3)
	Medium decile	15.3 (13.3, 17.4)	20.8 (18.5, 23.2)	11.5 (10.0, 13.0)
	High decile	11.9 (10.2, 13.7)	15.4 (13.2, 17.7)	7.3 (5.5, 9.1)
	Asian	5.5 (3.5, 7.5)	7.6 (4.7, 10.6)	3.7 (1.4, 6.0)
	NZEO	11.4 (10.1, 12.6)	16.1 (14.8, 17.5)	8.4 (7.1, 9.7)
	Māori	29.2 (26.6, 31.8)	35.0 (31.8, 38.2)	19.3 (16.7, 21.9)
	Pacific	17.2 (13.4, 20.9)	24.2 (19.4, 28.9)	14.2 (12.0, 16.4)

Proportions are adjusted for weighting and clustering.

Number of risk behaviours, by year

The proportion of students who reported engaging in none of the four risk behaviours of interest rose from approximately 60% (95% CI 56.1, 62.2) in 2001 to 80% (95% CI 77.6, 81.5) in 2012 (data not shown). As shown in Figure 42, this corresponded with a decline over time in the proportion reporting one, two, three or all four risk behaviours.

Figure 42: Number of risk behaviours reported, by survey year



It is important to note that analysis of number of risk behaviours was restricted to individuals with available data for all four risk behaviour outcomes. This excluded 16% of respondents in 2001, 22% in 2007 and 6% in 2012. Sensitivity analysis showed that although there was considerable uncertainty about the 'true' population estimates, the pattern was consistent under all assumptions about item non-responders: there was as increase over the study period in abstinence from all risk behaviours, and a decrease in multiple risk behaviours.

Associations between predictors and outcomes

Analysis confirmed that the factors identified in the international literature as predictors of risk behaviour in multiple domains were indeed associated with all four outcomes in the New Zealand secondary school population aged less than 16.

Home setting

Associations between predictors in the home setting and adolescent risk behaviour, expressed as ORs adjusted for demographic factors, are shown in Table 25. For each predictor, the likelihood of engaging in each risk behaviour compared to the reference group is presented. For example, compared to those who reported high parental monitoring, those who reported low parental monitoring were more than twice as likely to engage in smoking, cannabis use, binge drinking and sexually activity.

Table 25: Bivariate relationships between home setting variables and risk behaviours, 2001 - 2012 (pooled)

	Past month smoking OR (95% CI)	Past month cannabis use OR (95% CI)	Past month binge drinking OR (95% CI)	Sexually active OR (95% CI)
Parental monitoring Ref: High	1	1	1	1
Medium	1.29*** (1.22, 1.37)	1.38*** (1.31, 1.47)	1.38*** (1.32, 1.43)	1.11*** (1.06, 1.17)
Low	2.37*** (2.21, 2.54)	2.41*** (2.24, 2.58)	2.27*** (2.15, 2.41)	2.07*** (1.95, 2.20)
Fun with family Ref: A lot	1	1	1	1
Sometimes	1.45*** (1.36, 1.53)	1.58*** (1.49, 1.68)	1.29*** (1.24, 1.35)	1.22*** (1.16, 1.28)
Not at all	4.42*** (3.98, 4.91)	4.97*** (4.48, 5.52)	3.23*** (2.95, 3.52)	3.90*** (3.57, 4.27)
Maternal warmth Ref: high	1	1	1	1
Medium	1.57*** (1.48, 1.67)	1.72*** (1.62, 1.82)	1.65*** (1.58, 1.73)	1.68*** 1.60, 1.76
Low	3.31*** (3.01, 3.64)	3.43*** (3.12, 3.77)	2.43*** (2.24, 2.63)	3.43*** (3.16, 3.72)
No mother figure	2.76*** (2.35, 3.23)	2.46*** (2.08, 2.90)	2.19*** (1.92, 2.51)	3.48*** (3.05, 3.98)
Maternal closeness Ref: most of the time	1	1	1	1
Sometimes	1.49*** (1.40, 1.58)	1.61*** (1.52, 1.70)	1.56*** (1.49, 1.62)	1.57*** (1.50, 1.65)
Hardly ever	3.05*** (2.82, 3.29)	2.85*** (2.63, 3.08)	2.57*** (2.41, 2.74)	2.88*** (2.69, 3.08)
No mother figure	2.81*** (2.38, 3.32)	2.39*** (2.01, 2.84)	2.22*** (1.93, 2.55)	3.11*** (2.71, 3.58)
Paternal warmth Ref: high	1	1	1	1
Medium	1.57*** (1.47, 1.66)	1.57*** (1.48, 1.66)	1.41*** (1.35, 1.47)	1.42*** (1.35, 1.49)
Low	2.85*** (2.65, 3.07)	2.49*** (2.31, 2.68)	2.33*** (2.20, 2.46)	2.63*** (2.48, 2.80)
No father figure	2.31*** (2.10, 2.54)	2.40*** (2.19, 2.64)	1.70*** (1.57, 1.83)	2.34*** (2.17, 2.54)
Paternal closeness Ref: most of the time	1	1	1	1
Sometimes	1.40*** (1.32, 1.49)	1.55*** (1.46, 1.65)	1.46*** (1.40, 1.52)	1.32*** (1.26, 1.39)
Hardly ever	2.82*** (2.63, 3.02)	2.67*** (2.49, 2.86)	2.30*** (2.18, 2.43)	2.46*** (2.32, 2.61)

	Past month smoking OR (95% CI)	Past month cannabis use OR (95% CI)	Past month binge drinking OR (95% CI)	Sexually active OR (95% CI)
No father figure	2.44*** (2.21 2.69)	2.55*** (2.32, 2.81)	1.69*** (1.56, 1.83)	2.31*** (2.13, 2.50)
Relationship with family (ref = happy)				
Neutral	1.90*** (1.79, 2.01)	1.77*** (1.67, 1.87)	1.60*** (1.54, 1.67)	1.59*** (1.51, 1.66)
Problems	3.47*** (3.21, 3.75)	3.21*** (2.97, 3.47)	2.97*** (2.78, 3.16)	3.26*** (3.04, 3.49)

**p<.01 **p<.001 ***p<.0001*

All models are adjusted for age, sex, ethnicity and school decile

The findings show that parental monitoring, having fun with family, maternal and paternal warmth, maternal and paternal closeness, and happy family relationships were all strongly negatively associated with smoking, cannabis use, binge drinking and early sexual activity. All associations were highly statistically significant (p<.0001), and the consistency in the strength and direction of association for the four risk behaviours was striking.

For all four behaviours the strongest association was with 'Fun with family'; after adjusting for age, sex, school decile and ethnicity, those who reported they did not have fun with their family at all were more than four times as likely to smoke, about five times as likely to use cannabis, more than three times as likely to binge drink, and nearly four times as likely to be sexually active as adolescents who reported they had a lot of fun with their family. Fortunately, those who reported not having fun with family at all were a small group: 3-5% of the sample.

School setting

Table 26 shows associations between variables in the school setting and adolescent risk behaviours. Again, all the included predictors were strongly associated with all the outcomes (p<.0001). The strength of association was broadly similar across the four behavioural domains, though school factors appear to be particularly strongly associated with smoking and cannabis use. For example lack of belonging at school, a perception that people at school do not expect the respondent to do well, and intention to leave school before Year 13 were all more strongly associated with smoking and cannabis use than with binge drinking or sexual activity.

Table 26: Bivariate relationships between school setting variables and risk behaviours, 2001-2012 (pooled)

	Past month smoking OR (95% CI)	Past month cannabis use OR (95% CI)	Past month binge drinking OR (95% CI)	Sexually active OR (95% CI)
Intention to complete school Ref = yes	1	1	1	1
No	3.94*** (3.73, 4.16)	3.68*** (3.49, 3.88)	2.77*** (2.66, 2.89)	2.74*** (2.61, 2.87)
Plans after leaving school Ref = further educ/training	1	1	1	1
Look for a job	2.29*** (2.17, 2.43)	1.87*** (1.77, 1.98)	1.60*** (1.53, 1.67)	1.63*** (1.55, 1.71)
Have a family	3.06*** (2.51, 3.17)	2.23*** (1.80, 2.72)	2.95*** (2.50, 3.47)	5.52*** (4.74, 6.43)
Do nothing	9.75*** (7.72, 12.31)	9.64*** (7.62, 12.19)	5.45*** (4.35, 6.84)	8.92*** (7.14, 11.14)
Don't know/no plans	1.77*** (1.63, 1.93)	1.80*** (1.66, 1.95)	1.32*** (1.24, 1.40)	1.33*** (1.23, 1.43)
Students are treated fairly Ref = most of the time	1	1	1	1
Sometimes	1.94*** (1.82, 2.06)	2.18*** (2.05, 2.31)	2.04*** (1.96, 2.12)	1.81*** (1.72, 1.89)
Hardly ever	4.37*** (4.04, 4.72)	4.86*** (4.50, 5.25)	4.73*** (4.45, 5.03)	4.28*** (4.01, 4.57)
Sense of belonging Ref = yes	1	1	1	1
No	2.51*** (2.37, 2.67)	2.31*** (2.17, 2.45)	1.93*** (1.83, 2.02)	1.92*** (1.82, 2.03)
School expectations Ref = yes	1	1	1	
No	2.26*** (2.11, 2.43)	2.31*** (2.15, 2.48)	1.79*** (1.69, 1.90)	1.99*** (1.87, 2.12)

**p<.01 **p<.001 ***p<.0001*

All models are adjusted for age, sex, ethnicity and school decile

It is notable that for both home and school variables, ORs for past month binge drinking tend to be slightly lower than for other risk behaviours. This may reflect that binge drinking is more widespread in the adolescent population (with roughly double the prevalence of smoking or cannabis use) and may be less strongly associated with adversity and/or psychosocial problems.

Leisure setting

Odds ratios for leisure time variables are shown in Table 27. Again, analysis confirmed that both having a part time job and spending more than an hour per day hanging out with friends were associated with elevated likelihood of all four risk behaviours. Having a regular part time job was more strongly associated with binge drinking and sexual activity than with tobacco or cannabis use. Broadly, there was a dose-response relationship between time hanging out with friends and risk behaviour, though the relationship with tobacco was weaker than with other risk behaviours. In the general population (and in non-smokers, non-binge drinkers, etc) time hanging out with friends was approximately normally distributed (i.e. few at the extremes, most in the middle), whereas among those who engaged in risk behaviour the distribution was heavily skewed towards more time with friends. For example about 17% of the pooled sample reported spending 5+ hours per day with friends compared to nearly 40% of smokers, 35% of cannabis users, 30% of binge drinkers, and 30% of those who were sexually active.

Table 27: Bivariate relationships between leisure time variables and risk behaviours, 2001-2012 (pooled)

	Past month smoking	**Past month cannabis use**	**Past month binge drinking**	**Sexually active**
Regular part-time job Ref = no	1	1	1	1
yes	1.33*** (1.26, 1.41)	1.19*** (1.13, 1.26)	1.57*** (1.51, 1.63)	1.67*** (1.59, 1.74)
Time with friends/ Day Ref = none	1	1	1	1
Less than 1 hr	0.96 (0.81, 1.13)	1.55*** (1.30, 1.86)	1.62*** (1.46, 1.80)	1.40*** (1.25, 1.57)
1-2 hours	1.20* (1.03, 1.39)	1.96*** (1.65, 2.32)	2.04*** (1.85, 2.26)	1.66*** (1.49, 1.85)
3-4 hours	1.66*** (1.43, 1.94)	3.73*** (3.14, 4.42)	3.20*** (2.89, 3.55)	2.60*** (2.33, 2.91)
5+ hours	3.68*** (3.18, 4.26)	5.95*** (5.02, 7.04)	5.26*** (4.74, 5.83)	4.19*** (3.75, 4.68)

**p<.01 **p<.001 ***p<.0001*

All models are adjusted for age, sex, ethnicity and school decile

Summary: Associations between predictors and risk behaviours

In summary, this analysis confirmed that all of the predictors identified in the international literature were strongly associated with all four outcomes (past month smoking, past month cannabis use, past month binge drinking and being sexually active) in New Zealand secondary

students aged under 16 years. The strength of association was generally similar across outcomes, which supports the validity of the 'common predictor' construct.

Has exposure to predictors changed over time?

Home factors

Analysis revealed that, among home factors, parental monitoring (Fig 43), perceived relationship with family (Fig 44) and closeness to mother (Fig 45) improved modestly between 2001 and 2012. Changes over time in the other home factors examined were not statistically significant, or were not in a direction consistent with declining substance use.

As shown in Figure 43, the proportion of students who reported their family 'always' wanted to know who they were with and where they were increased significantly from 50.8% (95% CI: 48.7, 53.0) in 2001 to 62.3% (59.9, 64.7) in 2012. Meanwhile, the proportion who reported parental monitoring only occurred 'sometimes' or 'hardly ever' almost halved from 16.2% (15.0, 17.4) to 8.3% (7.4, 9.1).

Figure 43: Student-reported parental monitoring, by survey year

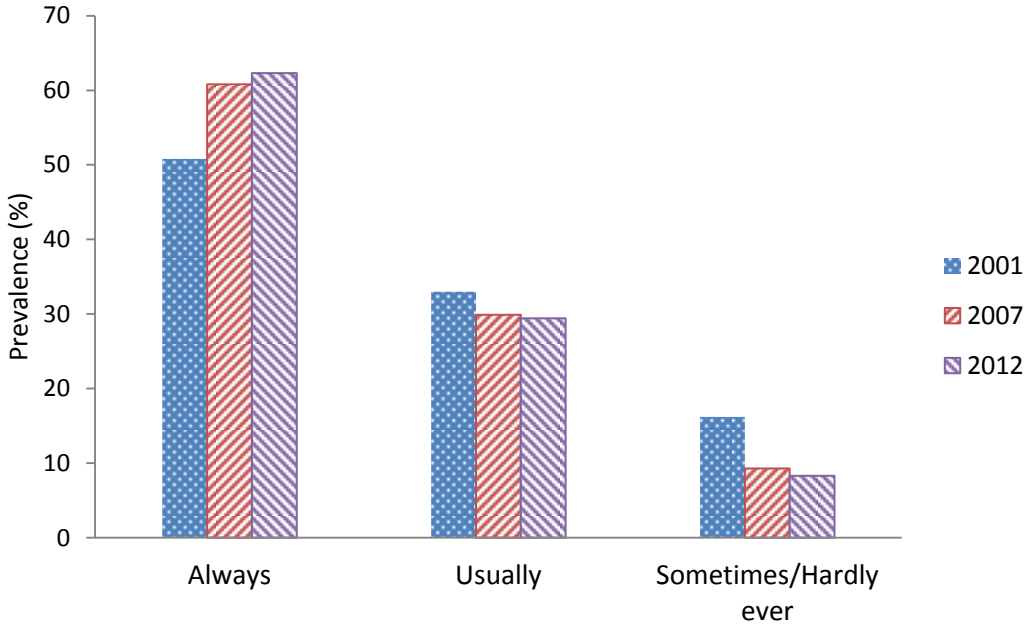
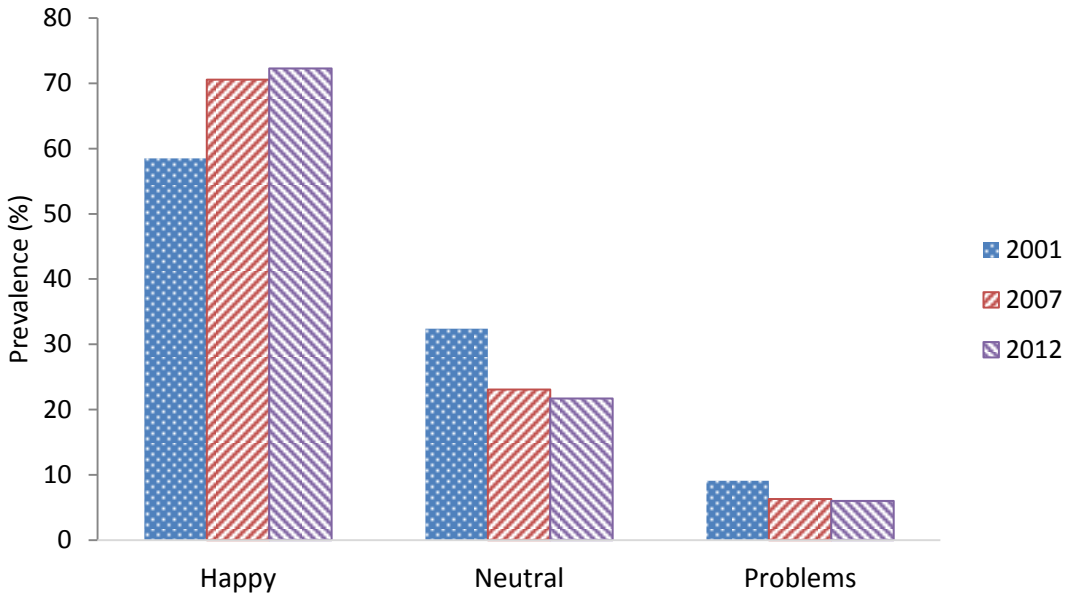


Figure 44 shows that the proportion of students who reported being happy about how they got on with their family rose from 58.5% (56.9, 60.2) in 2001 to 72.3% (71.1, 73.5) in 2012, while the proportion who said their family relationships were neither good nor bad fell from nearly a third of students, to just over one in five. Those who said that getting on with their

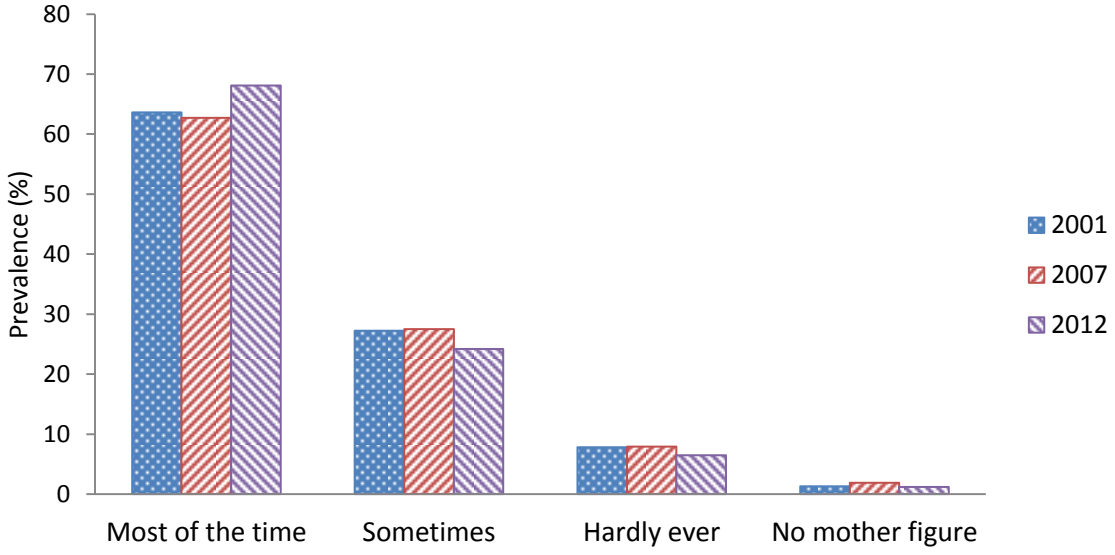
family was causing them problems were a minority in all years, but this minority shrank significantly from 9.1% (8.2, 10.0) to 6.0% (5.2, 6.7) over the study period.

Figure 44: Perceived relationship with family, by survey year



As shown in Figure 45, there was a small but statistically significant increase in the proportion who reported feeling close to their mother (or person who acts as their mother) 'most of the time' from 63.6% (62.0, 65.2) in 2001 to 68.1% (66.5, 69.6) in 2012.

Figure 45: Closeness to mother, by survey year

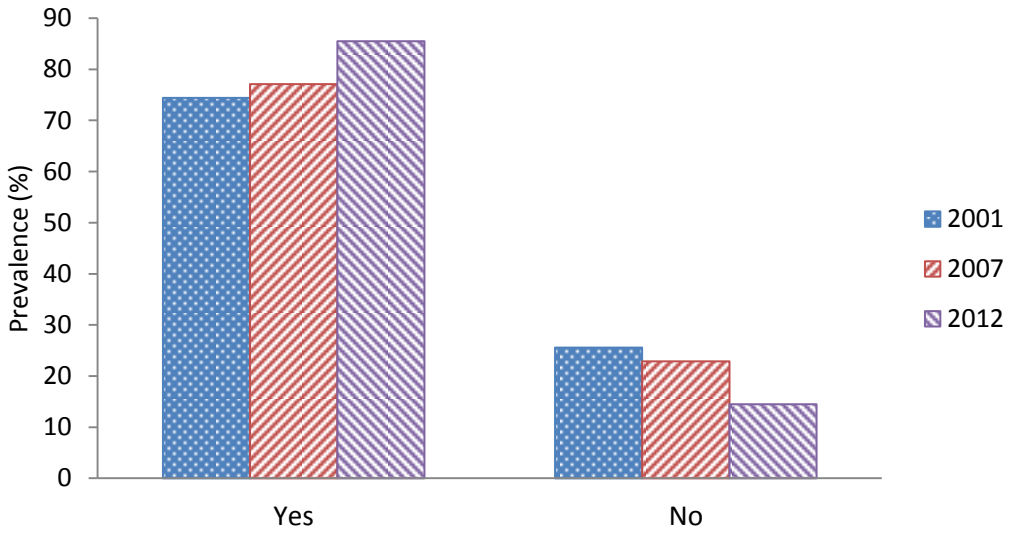


Factors that did not change significantly over the study period were maternal warmth and closeness to father. Some factors showed slight declines, for example there was a small but statistically significant decline in those reporting high paternal warmth, from 61.7% (60.1, 63.3) in 2001 to 56.6% (54.8, 58.5) in 2012. This was a surprising finding given popular perceptions and international research demonstrating closer father-adolescent relationships in recently years (Stevens et al. 2018). The proportion reporting they had 'a lot' of fun with their family also declined slightly over the study period from 36.3% (34.9, 37.6) in 2001 to 30.9% (28.8, 33.0) in 2012, although inconsistency in the wording of the answer categories between 2001 and 2007/12 may have biased the results. There was no statistically significant change between 2007 and 2012 when the wording of the answer categories was identical.

School factors

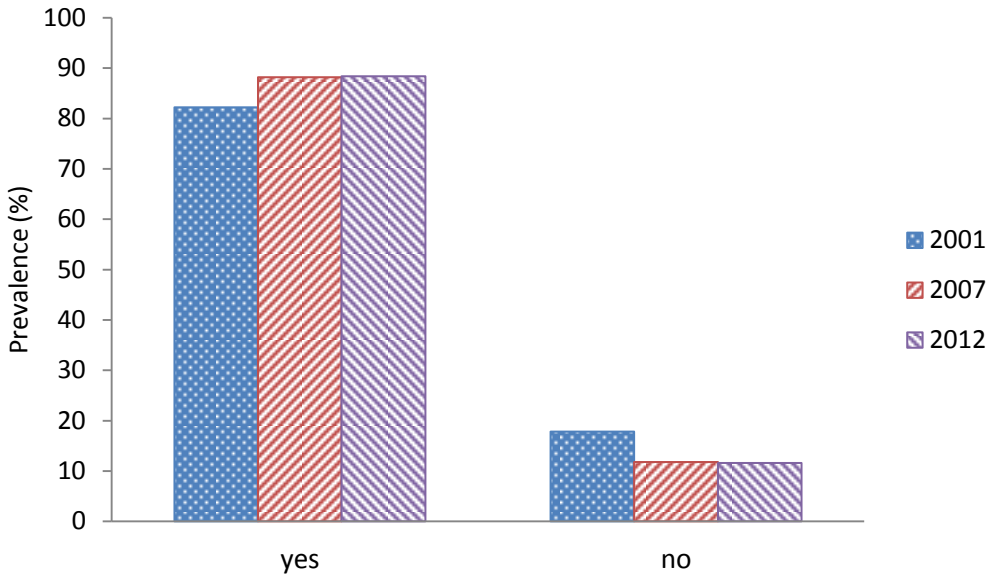
Three of the five school factors examined showed a change over time in a direction consistent with declining risk behaviour: intention to complete school (Figure 46), sense of belonging (Figure 47) and perception that students are treated fairly by teachers (Figure 48). As discussed below, these changes were modest, but statistically significant.

Figure 46: Intention to complete school, by survey year



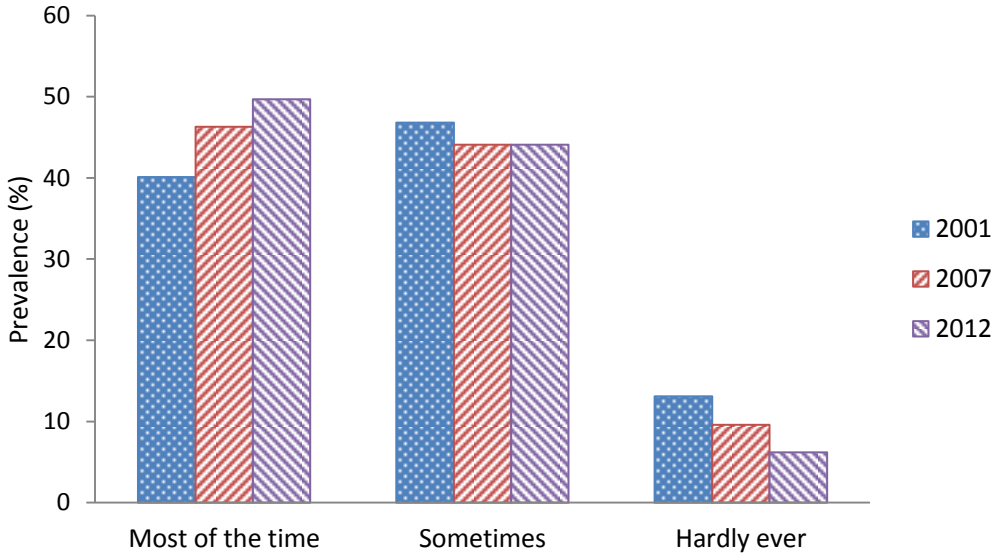
The proportion who intended to complete school increased from 74% (72.4, 76.4) in 2001 to 86% (83.9, 87.1) in 2012 (Figure 46), with most of this increase occurring in the 2007-2012 period. Intention to complete school was high in students from all school deciles, and absolute differences by school decile did not change significantly over time. The proportion of students from low decile schools who intended to complete school rose from 72% to 83%, while at high decile schools it rose from 78% to 89%.

Figure 47: Sense of belonging at school, by year



There was also a modest but statistically significant increase in the proportion who felt they belonged at their school, from 82% (81.3, 83.2) in 2001 to 88% (87.1, 89.6) in both 2007 and 2012 (Fig 47). Sense of belonging was slightly higher in students from low decile schools (85% in 2001 rising to 93% in 2012) than from medium or high decile schools, and the magnitude of this absolute difference did not change markedly over time.

Figure 48: Perceived fairness of teachers, by year



As shown in Figure 48, the proportion of students who felt that teachers at their school treated students fairly 'most of the time' increased steadily between 2001 (40%) and 2012

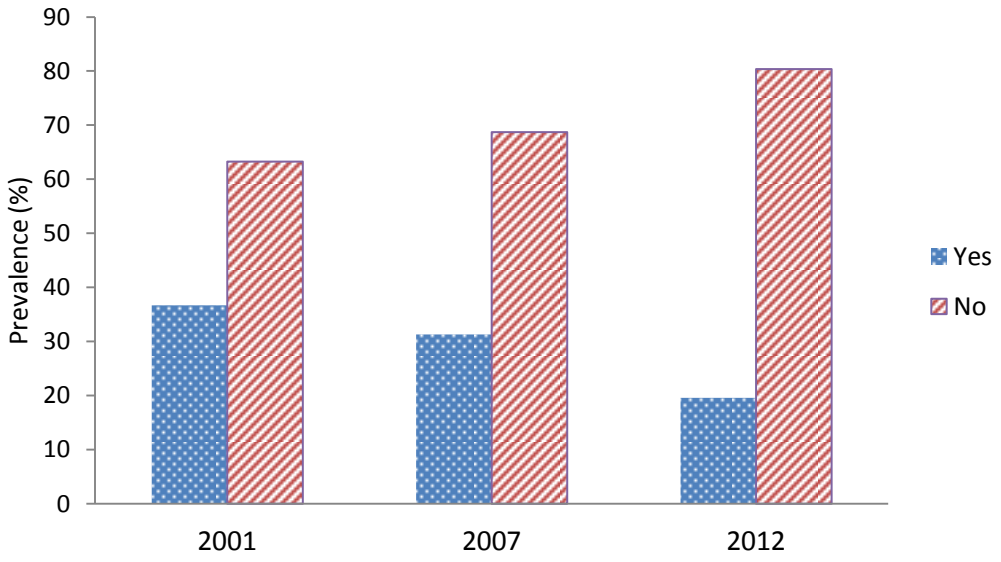
(50%). There was a corresponding decline in students who felt students were 'hardly ever' treated fairly. Students at high decile schools were more likely to report being treated fairly than students at low decile schools (e.g. in 2012, 54% of high decile students replied 'most of the time' compared with 45% of low decile students), and this absolute difference did not change markedly over time. However, differences by school decile in those replying 'hardly ever' were not marked, and became statistically insignificant in 2007 and 2012.

Taken together, these indicators suggest a modest increase in school connectedness between 2001 and 2012, which has occurred across all school deciles. However not all school factors showed an improvement over time. School expectations did not change significantly: the vast majority of respondents (89% in 2001 and 91% in 2012) reported that people at school expected them to do well. Results did not differ by school decile. In addition, the proportion planning further study or training after leaving school declined slightly, but not statistically significantly, between 2001 (64%, 95% CI: 61.3, 66.4) and 2012 (60%, 95% CI: 57.5, 62.3). This was surprising, given recent rhetoric about the 'knowledge economy', but may reflect the increasing personal costs of tertiary education in New Zealand and unwillingness of young people to take on student debt given increasing uncertainty and precariousness in the job market (France 2016).

Leisure time

The proportion of students with a regular part time job decreased markedly over the study period from 37% (34.4, 38.9) in 2001 to 20% (17.8, 21.3) in 2012, as shown in Figure 49.

Figure 49: Regular part-time work, by survey year

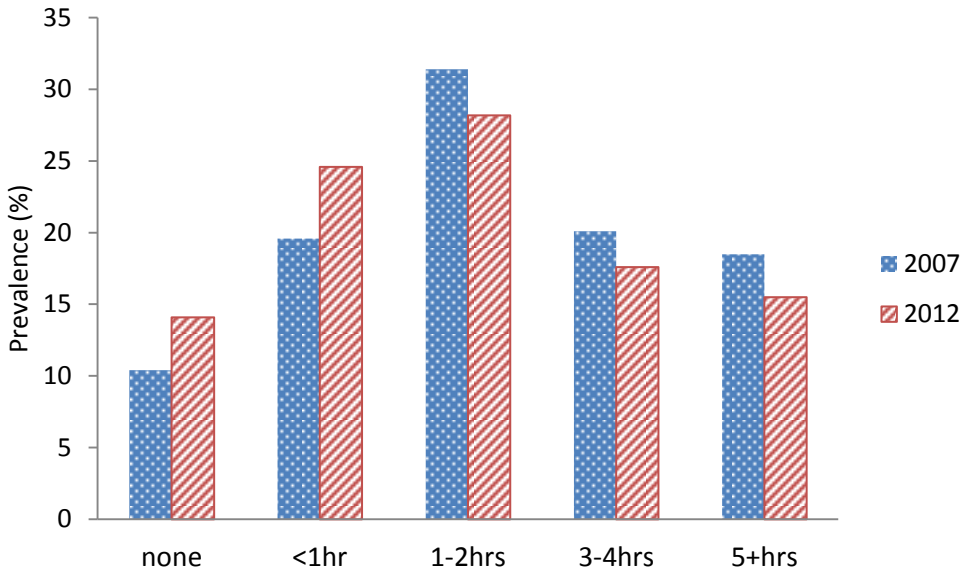


Arguably, this decline could be due to a structural shift away from regular part time work towards casual work. However further analysis suggests this explanation is unlikely. In 2007 and 2012, students were also asked about holiday, casual or occasional work for pay (excluding jobs around the house), as well as regular part time work. Based on this more inclusive definition of paid work, the proportion employed fell from 56% in 2007 to 43% in 2012. This suggests that student employment of all types has declined over time; the decline is not limited to regular part time work.

Time hanging out with friends

As shown in Figure 50, time spent hanging out with friends decreased between 2007 and 2012. (Note that data was not available in 2001.) The proportion that did not hang out with friends at all, or spent less than an hour hanging out with friends increased between 2007 and 2012. There was a corresponding decrease in the proportion that spent more than an hour hanging out with friends, with declines in 1-2 hour, 3-4 hour and 5+ hour categories.

Figure 50: Time spent hanging out with friends each day, by survey year



Summary: Changing exposure to predictors

In summary, prevalence of exposure to many predictors common to multiple risk behaviours has changed over the 2001 to 2012 period in a direction consistent with declining risk behaviours. This includes factors in the home setting (parental monitoring, perceived quality of family relationships, and closeness to mother), the school setting (sense of belonging at school, perceived fairness of teachers, and intention to complete secondary school) and

leisure time (having a part time job, time spent hanging out with friends). These changes have generally been quite modest, compared to the dramatic shifts observed in risk behaviours.

Do common predictors account for change over time?

The final stage of the analysis tested the extent to which common predictors accounted for the declines in smoking, cannabis use, binge drinking and sexual activity observed between 2001 and 2012. Factors for which exposure changed in a direction consistent with declining risk behaviour (based on the analysis above) are highlighted in the results tables below.

First, each predictor was tested individually. Table 28 shows the results for home factors, with the 'base model' (Model 1) in the left hand column showing the OR for year, i.e. the likelihood of smoking in 2007 and 2012 compared with 2001. When 'parental monitoring' was added to the base model (Model 1+ Parental monitoring) the OR for year was slightly attenuated for all outcomes, however the difference from the 'base model' was not statistically significant. The same was true when 'family relationship' was added to the base model (Model 1 + Family relationship). Adding 'Closeness to mother' to the base model did not attenuate the ORs for substance use, and only attenuated the OR for sexual activity very slightly (and non-significantly). When the other four home factors – fun with family, closeness to father, maternal and paternal warmth – were added to the model, the OR for year moved away from (rather than closer to) 1. This suggests these factors provided upward rather than downward pressure on adolescent risk behaviours over the study period. This is consistent with the analysis in the previous section showing that exposure to these variables did not change in a direction consistent with declining adolescent risk behaviour.

Table 28: 2001-2012 trend analysis, testing whether predictors in the home setting account for trends in risk behaviours

Year	Model 1: OR for Year Partially adjusted	Model 1 + Parental monitoring (95% CI)	Model 1+ Fun with family (95% CI)	Model 1 + Family relationship (95% CI)	Model 1 + Closeness to mother (95% CI)	Model 1+ Closeness to father (95% CI)	Model 1+ Maternal warmth (95% CI)	Model 1+ Paternal warmth (95% CI)
	Tobacco							
2001	1	1	1	1	1	1	1	1
2007	0.48 (0.41, 0.57)	0.52 (0.44, 0.62)	0.46 (0.39, 0.55)	0.53 (0.44, 0.62)	0.47 (0.40, 0.55)	0.46 (0.39, 0.55)	0.45 (0.38, 0.53)	0.45 (0.38, 0.53)
2012	0.20 (0.17, 0.23)	0.21 (0.18, 0.25)	0.19 (0.16, 0.23)	0.21 (0.17, 0.25)	0.20 (0.16, 0.23)	0.19 (0.16, 0.23)	0.19 (0.16, 0.23)	0.19 (0.16, 0.23)
	Cannabis							
2001	1	1	1	1	1	1	1	1
2007	0.58 (0.48, 0.69)	0.63 (0.53, 0.75)	0.54 (0.46, 0.65)	0.62 (0.52, 0.74)	0.56 (0.47, 0.66)	0.55 (0.46, 0.66)	0.52 (0.44, 0.62)	0.53 (0.45, 0.64)
2012	0.32 (0.26, 0.38)	0.34 (0.29, 0.41)	0.31 (0.26, 0.37)	0.34 (0.29, 0.41)	0.32 (0.27, 0.38)	0.31 (0.26, 0.37)	0.30 (0.25, 0.36)	0.31 (0.26, 0.37)
	Binge drinking							
2001	1	1	1	1	1	1	1	1
2007	0.77 (0.68, 0.88)	0.83 (0.73, 0.95)	0.75 (0.66, 0.86)	0.83 (0.73, 0.95)	0.76 (0.67, 0.87)	0.75 (0.66, 0.86)	0.73 (0.64, 0.84)	0.73 (0.64, 0.84)
2012	0.33 (0.29, 0.37)	0.35 (0.31, 0.40)	0.32 (0.28, 0.36)	0.34 (0.30, 0.39)	0.33 (0.29, 0.37)	0.32 (0.28, 0.36)	0.32 (0.28, 0.36)	0.32 (0.28, 0.36)

	Sexually active							
2001	1	1	1	1	1	1	1	1
2007	1.56 (1.37, 1.78)	1.68 (1.48, 1.91)	1.53 (1.35, 1.74)	1.71 (1.50, 1.94)	1.54 (1.35, 1.75)	1.54 (1.36, 1.75)	1.47 (1.29, 1.67)	1.50 (1.32, 1.71)
2012	0.68 (0.60, 0.76)	0.74 (0.65, 0.84)	0.67 (0.59, 0.77)	0.74 (0.65, 0.84)	0.69 (0.61, 0.79)	0.67 (0.59, 0.76)	0.66 (0.58, 0.75)	0.67 (0.58, 0.76)

All models are adjusted for age, sex, ethnicity and school decile.

Shading indicates factors for which exposure changed in a direction consistent with declining risk behaviour.

Results for school factors are presented in Table 29. The OR for year moved in the expected direction (i.e. towards 1) for all four risk behaviour outcomes when 'students treated fairly', 'sense of belonging at school' and 'intention to complete school' were added to the base model individually, but effect sizes were small and not statistically significant. Addition of 'school expects me to do well' slightly (but non-significantly) attenuated the ORs for cannabis use and sexual activity, but not the other outcomes. The addition of 'plans after leaving school' moved the OR in the opposite direction, which was expected given the proportion planning to continue study or training after secondary school declined over time.

Table 29: 2001-2012 trend analysis, testing whether predictors in the school setting account for trends in risk behaviours

Year	Model 1: OR for Year Partially adjusted (95% CI)	Model 1 + Students treated fairly (95% CI)	Model 1 + Sense of belonging at school (95% CI)	Model 1+ School expects me to do well (95% CI)	Model 1 + Intention to complete school (95% CI)	Model 1 + Plans after leaving school (95% CI)
	Past month smoking					
2001	1	1	1	1	1	1
2007	0.48 (0.41, 0.57)	0.52 (0.44, 0.61)	0.53 (0.44, 0.62)	0.50 (0.43, 0.60)	0.49 (0.42, 0.59)	0.47 (0.40, 0.55)
2012	0.20 (0.17, 0.23)	0.22 (0.18, 0.26)	0.21 (0.17, 0.25)	0.20 (0.17, 0.24)	0.23 (0.19, 0.27)	0.19 (0.16, 0.22)
	Past month cannabis use					
2001	1	1	1	1	1	1
2007	0.58 (0.48, 0.69)	0.63 (0.52, 0.75)	0.62 (0.52, 0.74)	0.60 (0.50, 0.71)	0.60 (0.50, 0.72)	0.57 (0.48, 0.67)
2012	0.32 (0.26, 0.38)	0.35 (0.29, 0.42)	0.33 (0.28, 0.40)	0.33 (0.27, 0.39)	0.37 (0.30, 0.44)	0.31 (0.26, 0.36)
	Past month binge drinking					
2001	1	1	1	1	1	1
2007	0.77 (0.68, 0.88)	0.84 (0.73, 0.96)	0.81 (0.71, 0.93)	0.79 (0.69, 0.91)	0.79 (0.69, 0.90)	0.77 (0.67, 0.88)
2012	0.33 (0.29, 0.37)	0.36 (0.31, 0.41)	0.34 (0.29, 0.38)	0.33 (0.29, 0.38)	0.36 (0.31, 0.41)	0.32 (0.28, 0.36)
	Sexually active					
2001	1	1	1	1	1	1
2007	1.56 (1.37, 1.78)	1.74 (1.53, 1.99)	1.68 (1.48, 1.92)	1.62 (1.42, 1.84)	1.65 (1.45, 1.87)	1.57 (1.38, 1.78)
2012	0.68 (0.60, 0.78)	0.77 (0.68, 0.89)	0.72 (0.63, 0.83)	0.70 (0.61, 0.80)	0.78 (0.68, 0.89)	0.66 (0.58, 0.76)

All models are adjusted for age, sex, ethnicity and school decile

Turning to factors in the leisure sphere, Table 30 shows that when the 'regular part time job' variable was added to the base model, again a small but non-significant attenuation of the OR for year can be seen. The attenuation effect was greater for sexual activity than any of the substance use outcomes, but none reached statistical significance.

Table 30: 2001-2012 trend analysis, testing whether student employment accounts for trends in risk behaviours

Year	Model 1: OR for Year Partially adjusted (95% CI)	Model 1 + Regular part time job
	Tobacco	
2001	1	1
2007	0.48 (0.41, 0.57)	0.50 (0.43, 0.59)
2012	0.20 (0.17, 0.23)	0.21 (0.17, 0.25)
	Cannabis	
2001	1	1
2007	0.58 (0.48, 0.69)	0.59 (0.49, 0.71)
2012	0.32 (0.26, 0.38)	0.34 (0.28, 0.40)
	Binge drinking	
2001	1	1
2007	0.77 (0.68, 0.88)	0.79 (0.70, 0.91)
2012	0.33 (0.29, 0.37)	0.35 (0.30, 0.40)
	Sexually active	
2001	1	1
2007	1.56 (1.37, 1.78)	1.68 (1.46, 1.90)
2012	0.68 (0.60, 0.78)	0.76 (0.66, 0.87)

All models are adjusted for age, sex, ethnicity and school decile

'Time hanging out with friends' was not available in 2001, so to test this variable a base model using 2007 as the reference year was constructed (Table 31). When 'time hanging out with friends' was added to the base model a small but non-significant attenuation of the OR for year was observed in all outcome variables. The effect was greatest for binge drinking, but did not reach statistical significance for any of the outcomes.

Table 31: 2007-2012 trend analysis, testing whether time hanging out with friends accounts for trends in risk behaviours

Year	Model 2: OR for Year Partially adjusted (95% CI)	Model 2 + Time hanging out with friends
	Tobacco	
2007	1	1
2012	0.41 (0.37, 0.44)	0.43 (0.39, 0.47)
	Cannabis	
2007	1	1
2012	0.56 (0.52, 0.61)	0.60 (0.55, 0.65)
	Binge drinking	
2007	1	1
2012	0.42 (0.40, 0.45)	0.46 (0.43, 0.48)
	Sexual activity	
2007	1	1
2012	0.44 (0.42, 0.47)	0.46 (0.43, 049)

All models are adjusted for age, sex, ethnicity and school decile

In summary, whilst addition of some of the predictors resulted in slight attenuation, these effects were small and not statistically significant. However, it is possible that, collectively, they may have contributed to the observed trends.

The next stage of the analysis tested this hypothesis, and included only contributing variables, that is those that attenuated the OR for year (however slightly) for one or more outcomes.Table 32 shows the OR for year for each outcome, adjusted for age, sex, ethnicity and school decile, in column one (Model 1).

Table 32: 2001-2012 trend analysis, testing contributing predictors collectively

Year	Model 1: OR for Year Partially adjusted (95% CI)	Model 1+ Contributing home factors	Model 1 + Contributing school factors	Model 1 + Contributing home & school factors	Model 1 + all contributing factors (home, school, work)
	Tobacco				
2001	1	1	1	1	1
2007	0.48 (0.41, 0.57)	0.53 (0.45, 0.63)	0.55 (0.46, 0.65)	0.57 (0.47, 0.68)	0.58 (0.49, 0.70)
2012	0.20 (0.17, 0.23)	0.22 (0.18, 0.26)	0.24 (0.20, 0.29)	0.25* (0.21, 0.30)	0.25* (0.21, 0.31)
	Cannabis				
2001	1	1	1	1	1
2007	0.58 (0.48, 0.69)	0.63 (0.53, 0.75)	0.65 (0.54, 0.79)	0.68 (0.56, 0.81)	0.70 (0.57, 0.84)
2012	0.32 (0.26, 0.38)	0.36 (0.30, 0.43)	0.39 (0.32, 0.47)	0.41* (0.34, 0.50)	0.43* (0.36, 0.53)
	Binge drinking				
2001	1	1	1	1	1
2007	0.77 (0.68, 0.88)	0.85 (0.75, 0.97)	0.85 (0.73, 0.98)	0.88 (0.77, 1.02)	0.90 (0.78, 1.04)
2012	0.33 (0.29, 0.37)	0.36 (0.31, 0.41)	0.38 (0.33, 0.44)	0.39* (0.34, 0.45)	0.41* (0.36, 0.48)
	Sexual activity				
2001	1	1	1	1	1
2007	1.56 (1.37, 1.78)	1.72 (1.51, 1.95)	1.83 (1.60, 2.09)	1.88* (1.65, 2.15)	1.99* (1.73, 2.30)
2012	0.68 (0.60, 0.78)	0.77 (0.67, 0.88)	0.85* (0.74, 0.98)	0.89** (0.78, 1.02)	0.98*** (0.84, 1.13)

All models are adjusted for age, sex, ethnicity and school decile
**p<.05 **p<.01 ***p<.001 indicates OR is significantly different from Model 1 (base model).*

The next column (Model 1 + Home factors) adds the contributing home factors to the model in combination: parental monitoring, perceived quality of family relationships and closeness to mother. The attenuation of the OR is greater than for any of the home factors individually, but still does not reach statistical significance. Collectively, the contributing school factors (perceived fairness, sense of belonging, school expectations, and intention to complete school) attenuate the 2001-2012 trends to a greater extent than the home factors, and for sexual activity the attenuation effect of school factors reaches statistical significance. It is plausible that home and school factors are not independent; perhaps students who are happy and supported at home feel more positive about school (and vice versa). To test whether

home and school factors made independent contributions to the decline in adolescent risk behaviours, these factors were added to the model in combination. When home and school factors were combined (column four), the attenuation of the 2001-2012 trend was statistically significant for all four outcomes. The results suggest that although there is some overlap, home and school factors appear to have independent effects on risk behaviour trends.

Does the decline in student employment also help to explain risk behaviour trends, over and above the effect of home and school factors? With the addition of the 'part time job' variable (right hand column) the attenuation of the OR compared with the base model remained significant for all outcomes for the 2001-2012 period, and the effect size increased slightly for all outcomes except smoking. (Note that 'time hanging out with friends' cannot be included in this model since this variable was not included in the 2001 survey.) These findings suggest that factors in each domain (home, school and work) made a small but independent contribution, and collectively they partially accounted for the trends observed. For sexual activity, the shared predictors appear to completely account for the trend (i.e. OR 0.98 is not significantly different from 1). Notably, however, they only explain a small proportion of the declines in substance use observed over the study period.

As a supplementary analysis, I included *all* --not only contributing -- factors in the model (results not shown). Using this approach for home variables combined, the OR for year was only marginally different from the base model, suggesting that the contributing factors (parental monitoring, perceived quality of family relationship and closeness to mother) were almost completely counteracted by the other variables (fun with family, closeness to father, and maternal and paternal warmth). Addition of 'plans after leaving school' to the school factors model also counteracted the contributing factors, but to a lesser extent. Using this approach, the full model including all home, school, and work variables was only statistically significantly different from the base model for binge drinking and sexual behaviour.

A second model using 2007 as the reference year was created to enable the inclusion of 'time hanging out with friends'. The results are presented in Table 33. The first column (Model 2) shows the OR for year in the 'base' model. (Note that Model 2 + time with friends, was presented above in Table 31). The next three columns show the attenuation effect of adding contributing home factors, school factors, and part time work to the model, respectively. Home factors appear to contribute little if anything to the trends in the 2007-2012 period, whereas school factors and part time work each made a small (but non-significant) contribution. The 5th column shows the combined effect of home, school and work factors. In

combination the attenuation of the OR for year is greater, but only statistically significant for one outcome: sexual activity.

Table 33: 2007-2012 trend analysis, testing contributing predictors collectively

Year	Model 2: OR for Year Partially adjusted (95% CI)	Model 2+ Contributing home factors	Model 2 + Contributing school factors	Model 2 + Part time work	Model 2 + Contributing home, school & work	Model 2 + Contributing home, school, work, time with friends
	Tobacco					
2007	1	1	1	1	1	1
2012	0.41 (0.37, 0.44)	0.41 (0.37, 0.45)	0.44 (0.40, 0.49)	0.42 (0.39, 0.46)	0.44 (0.40, 0.49)	0.47* (0.43, 0.52)
	Cannabis					
2007	1	1	1	1	1	1
2012	0.56 (0.52, 0.61)	0.57 (0.53, 0.62)	0.60 (0.56, 0.66)	0.58 (0.54, 0.63)	0.63 (0.58, 0.68)	0.68** (0.62, 0.74)
	Binge drinking					
2007	1	1	1	1	1	1
2012	0.42 (0.40, 0.45)	0.42 (0.40, 0.45)	0.45 (0.42, 0.47)	0.44 (0.42, 0.47)	0.46 (0.44, 0.49)	0.49** (0.46, 0.52)
	Sexual activity					
2007	1	1	1	1	1	1
2012	0.44 (0.42, 0.47)	0.45 (0.43, 0.48)	0.47 (0.44, 0.50)	0.47 (0.44, 0.50)	0.50* (0.47, 0.54)	0.53*** (0.49, 0.56)

All models are adjusted for age, sex, ethnicity and school decile.
**p<.05 **p<.01 ***p<.001 indicates OR is significantly different from Model 1 (base model).*

When 'time with friends' was added such that all contributing predictors were included in the model collectively (right hand column), the OR for year was significantly attenuated for all outcomes. This indicates that, collectively, home, school and leisure factors (partially) account for the declines in smoking, drinking, cannabis use and sexual activity between 2007 and 2012, with school and leisure factors more important than home factors in this latter period. However the majority of the decline in all four outcomes remains unexplained.

Interestingly, although the included factors appeared to completely explain the decline in sexual activity over the full 2001-2012 study period (as discussed above and shown in Table 32), they only partially explain the 2007-2012 decline. Since the decline in sexual activity only occurred in the 2007-2012 period (rising during the first half of the study period), the 2007-2012 analysis presented in Table 33 may provide a more accurate picture of the contributors to the decline in sexual activity than that based on the whole study period.

Sensitivity analysis was conducted to test whether the conclusions of the trend analysis could be biased due to item non-response for the outcome variables (Appendix B). The finding that none of the included predictors – by itself – significantly accounted for the trends was robust to all assumptions about item non-responders. However the finding that, in combination, contributing home, school and leisure factors made a significant contribution to risk behaviour trends was vulnerable to non-response bias. Under the extreme assumption that all non-responders were past month users, the combined effect was smaller and did not reach statistical significance for smoking, cannabis or binge drinking. Thus, this finding should be treated with caution.

Discussion

Despite extensive research into the predictors of adolescent risk behaviours, few studies have explored how exposure to common predictors has changed over time, or how such changes may be contributing to changes in adolescent behaviour. This study is the first that I am aware of that empirically tests the contribution of known predictors in a range of domains (home, school and leisure) to downward trends in smoking, binge drinking, cannabis use and sexual activity among adolescents. As such, it makes an important contribution to understanding the under-researched phenomenon of declining adolescent risk behaviour.

I found that all of the included predictors were significantly associated with the outcomes of interest: past month smoking, past month cannabis use, past month binge drinking and sexual activity in the past three months. Student-reported exposure to many of the predictors changed significantly over the 2001-2012 period, mostly in a direction consistent with declining risk behaviour. Trend analysis showed that, individually, none of the included factors made a statistically significant contribution to trends in risk behaviours over the study period. *Collectively,* however, contributing factors explained a statistically significant (but still small) proportion of the decline in all four risk behaviours. Contributing factors were parental monitoring, perceived quality of family relationships, sense of belonging at school, perception that teachers treat students fairly, intention to complete secondary school, school expectations, having a part time job, and time hanging out with friends.

It is important to note that some of the other (non-contributing) factors were putting *upward* pressure on risk behaviours, which to a large degree counteracted the influence of the contributing factors. Furthermore, the sensitivity analysis showed non-response bias could be exaggerating the combined effect of the contributing predictors. Their true contribution may

be smaller than the complete case analysis suggests, and may not reach statistical significance for smoking, drinking or cannabis trends.

The findings were broadly similar across outcomes, but only explained a small proportion of the trend for each, providing little support for the 'unitary trend' hypothesis (Grucza, 2017). However it is possible that the Youth 2000 survey questions and answer categories did not adequately capture important contextual changes in home, school and leisure settings, thereby underestimating their contribution to risk behaviour trends. It must also be acknowledged that there are other potentially important common predictors that could not be examined in this study, for example: sensation seeking, risk preference, impulsiveness, experience of abuse or neglect in early childhood, and disposable income from work and allowances. Therefore it is possible that 'common liability' has played a more important role in the decline of adolescent risk behaviours than the findings of this study suggest.

The findings in relation to parental monitoring are consistent with two previous studies showing that although parental monitoring increased over time, this increase – by itself – did not significantly explain declines in adolescent drinking in Sweden (Larm et al. 2018) or cannabis use disorders in the USA (Grucza et al. 2016). International research suggests that *alcohol-specific* parenting practices (e.g. rules about adolescent alcohol use, and parental supply of alcohol) may be more important than *general* parenting practices in explaining declining adolescent alcohol use (Van Zundert et al. 2006, de Looze et al. 2014, de Looze et al. 2017, Toumbourou et al. 2018b). Similarly, parental rules and expectations about non-smoking have been shown to be key determinants of adolescent smoking behaviour (Waa et al. 2011). Unfortunately, the Youth 2000 survey did not include questions on alcohol-specific or tobacco-specific parenting, so exploration of their possible contribution was not possible within the current study.

The findings in relation to school connectedness are consistent with a recent Australian study which found prevalence of 'low commitment to school' decreased over time, but was not a significant determinant of declining adolescent alcohol use between 1999 and 2015 (Toumbourou et al. 2018b). This is consistent with the current study since only in combination with other factors did school factors significantly explain the decline in risk behaviours in New Zealand, and, as noted, that finding must be treated with caution.

Although school connectedness appears to have increased in New Zealand and Australia, this trend may not be common to all the countries of interest. For example, the Monitoring the

Future study in the USA shows the proportion of senior students who reported enjoying school has declined since 1990 (Twenge 2017), suggesting school connectedness may have declined rather than improved in the USA over the study period, at least among older adolescents. The possible contribution of school connectedness and school climate to declining risk behaviour has not been empirically explored outside of Australasia, as far as am aware, and is an avenue for future research.

'Time spent hanging out with friends' – on its own – did not significantly explain declines in substance use or sexual behaviour in the 2007 to 2012 period in New Zealand. This finding differs from a recent HBSC study of 25 countries that found declines in time spent with friends in the evenings partially explained the decline in adolescent alcohol use in many European countries (de Looze et al. 2019). This difference could be due to the fact that the Youth 2000 question is very broad, and may not have detected important shifts in the time and location of time spent with friends. For example friends may be increasingly hanging out at home under supervision, rather than going out together unsupervised. It is possible that a more specific question – about unsupervised time with friends in the evenings – might yield more definitive results in the New Zealand context.

Neither my findings nor the findings of the HBSC study referenced above support the hypothesis that an increase in digital media use has displaced adolescent risk behaviour via a decline in face to face socialising. If this were a key driver of declining adolescent behaviour, we would expect 'time spent hanging out with friends' to account for a significant proportion of the declines in risk behaviour between 2007 and 2012, the period during which home internet and social media reached mass penetration in New Zealand.[17] However, we cannot rule out the possibility that the digital revolution has influenced adolescent risk behaviour via other mechanisms, for example by changing the cultural position of risk behaviours such that they are less central to youth culture and youth identity (Törrönen et al. 2019).

The strengths and limitations of the study must be borne in mind when interpreting the findings. Strengths include a large, nationally representative sample, reasonably high response

[17] According to the New Zealand Census, home internet penetration increased from 35% of households in 2001 to 75% in 2013. Households in which the youngest occupant was aged 10-14 year were the most likely to have home internet access in 2001, at 56% of households. No comparable figure is available for 2013. Nationally representative NZ trend data for adolescent social media use and mobile phone ownership is not available. Internationally, Facebook usage grew exponentially between 2008 and 2012. Apple's first iPhone was released in 2007 but smartphones only became widely used by adolescents after about 2011. For example the proportion of Australians aged 14-17 with a smartphone increased from 23% in 2011 to 43% in 2012, and 80% in 2015 (Australian Communications and Media Authority, 2016).

rate and computer-assisted administration mode, which is less likely to lead to social desirability bias than other modes (Watson et al. 2001). The trend analysis is based on individual level data, enabling adjustment for covariates (age, sex, ethnicity, school decile) and avoiding some of the pitfalls associated with ecological studies (Wills & Soneji 2018).

Limitations include changes in question wording and answer categories that have affected comparability across years, in particular the assessment of sexual activity, family fun, and part time employment. For example sexual abuse and unwanted sex were explicitly excluded in 2007 and 2012, which may have had the effect of over-estimating sexual activity in 2001 relative to 2007 and 2012. Furthermore, response rates at the school and student levels have declined in successive surveys, which could also affect comparability across years. A further potential source of bias in adjusted models is residual confounding, since school decile is an imperfect measure of socio-economic status. And, as noted above, the available measures may not have adequately captured important contextual changes affecting adolescent behaviour.

As previously noted, item non-response for all four outcome variables was relatively high, and was greater in 2001 and 2007 than in 2012, potentially leading to bias. However sensitivity analysis demonstrated that the downward trends in risk behaviours over the study period were robust to even extreme assumptions about missing data. If anything, the trends are likely to be *under*estimated; the 'true' trend is likely to be steeper than that based on the complete case analysis. However, as discussed above, sensitivity analyses also highlighted the need for caution in relation to conclusions about the combined effect of contributing factors.

The fact that some of the hypothesised contributing factors turned out to have an *upward* rather than downward influence on risk behaviour trends highlights another limitation of the study approach. The purpose of the study (and the project more broadly) is to identify those factors that help to explain the decline in adolescent risk behaviour, but arguably this is a 'one sided' approach since factors that might be working in the opposite direction (e.g. exposure to online marketing) have not been sought out for inclusion. Future research could look at both upward and downward pressures on risk behaviour, though identifying *all* relevant factors is likely to be impossible, and therefore even the most comprehensive model will never be 'complete'.

The outcomes – smoking, binge drinking, cannabis use and sexually activity – were treated separately within this modelling approach. Future research could derive a latent 'risk

behaviour' variable, and examine the contribution of the identified predictors to the trend over time in 'risk behaviour' as a whole.

This chapter explored possible contributing factors one at a time and in groups according to setting. It did not explore in depth the relationships *between* the included predictors, nor did it investigate which of the predictors were independent contributors to risk behaviour decline after adjustment for all the other variables. The latter gap is addressed in Chapter 8, which examines the independent contribution of each predictor, after adjusting for the other predictors from the Youth 2000 surveys.

The trend analysis undertaken allows us to explore the relationships between survey year, predictors and outcomes, and thereby account for trends over time in statistical terms. This approach draws on existing knowledge about the predictors of adolescent risk behaviours and adds to the evidence base about the possible explanations for the observed declines. However, since it is based on cross-sectional data, this study cannot provide certainty about causality.

Conclusion

Individually, none of the included predictors significantly explained trends in substance use or sexual behaviour over the study period. The findings do not support popular hypotheses e.g. that digital media has displaced adolescent risk behaviour via a decline in face to face socialising, or that increased parental monitoring explains declining risk behaviour. On balance, it appears that, collectively, the common predictors identified in home, school and leisure settings made only a minor contribution to declines in adolescent risk behaviours in New Zealand between 2001 and 2012. Models including all the contributing predictors left the majority of the declines in adolescent smoking, cannabis use, binge drinking and sexual activity unexplained.

CHAPTER 7: AGE OF INITIATION, ATTITUDES, AND PARENTAL MODELLING

Introduction

The findings of Chapter 6 indicated that the common factors tested accounted for only a small proportion of the major shift in adolescent behaviour observed in New Zealand since 2001. Perhaps changes in attitudes and norms have played a more important role? This chapter tests that hypothesis, continuing my analysis of Youth 2000 data and exploring the role of i) age of initiation for risk behaviours, ii) changing adolescent attitudes towards substance use and iii) parental modelling as explanations for teen trends. These three distinct investigations are conceptually linked by the underlying concept of norms.

Background: Norms and how they influence behaviour

Norms may be descriptive (that is, what people typically do) or injunctive (that is, what people think people *should* do) (Anderson & Dunning 2014). Aggregate behaviour is an indicator of descriptive norms, with changes in what people commonly do indicating that descriptive norms have changed.

Children and adolescents are in the process of learning and internalising the 'rules' of how to live life among other humans, and the behaviour of others, particularly those closest to them – e.g. parents and peers – provides a blueprint for their own behaviour (White et al. 2000, Brechwald & Prinstein 2011). We all unthinkingly conform to behavioural norms every day, many of which are completely arbitrary (e.g. which way to face in an elevator) but which help to organise and coordinate social life (Anderson & Dunning 2014). Research has demonstrated that parental modelling (e.g. of smoking or drinking) is a strong predictor of adolescent and young adult behaviour (White et al. 2000). Research also shows that, at the individual level, perceived descriptive norms (i.e. what a participant *thinks* that other people do) is a strong predictor of behaviour, particularly with regard to risk behaviour among young people (Rivis & Sheeran 2003, Pocuca et al. 2019).

Descriptive norms may also influence individuals (independently of perceptions) via the availability of substances and the frequency of opportunities for use. For example, adolescents typically try cannabis for the first time when it is offered to them by another young person, often in a group situation. Young people living in communities where cannabis use is rare will

have fewer opportunities to try cannabis (regardless of their perceptions about how prevalent cannabis use is) than those in communities where cannabis use is widespread (Keyes et al. 2011, Burdzovic & Bretteville-Jensen 2017). Thus, descriptive norms may influence individual behaviour via a variety of mechanisms.

Injunctive norms are informal rules about acceptable and unacceptable behaviour, and exert social control via the promise of rewards (e.g. social approval, peer esteem) or punishments (e.g. social disapproval, peer rejection, or other sanctions) (Anderson & Dunning 2014). Indicators of injunctive norms at the population level include aggregate attitudes about the acceptability (or not) of a particular behaviour, and, at the individual level, perceptions about what others deem to be appropriate. Injunctive norms are not static or universal. As noted in Chapters 1 and 2, social attitudes towards a particular behaviour (e.g. pre-marital sex) may change greatly over time. Furthermore groups within a society may hold different views about appropriate behaviour, for example the current acceptability of recreational cannabis use is likely to vary widely according to age, religious affiliation, and ethnicity/culture. This diversity has implications for adolescents: gaining the approval of peers may risk the disapproval of parents, since the same behaviour may be endorsed by the former but disapproved of by the latter (or vice versa). This tension appears to be at the heart of many conflicts between parents and their adolescent children (Gray 1988).

The distinction between descriptive and injunctive norms is often blurred in practice. 'Typical' behaviour may come to be seen as 'correct' behaviour, so that those who break even arbitrary norms may be seen as 'weird' or 'antisocial' and suffer social disapproval or sanctions. But, particularly in the realm of health-related behaviour, it is clear that there is often a discrepancy between what people believe they and others *should* do (e.g. get plenty of physical activity, eat a healthy diet, refrain from smoking, use dental floss every day) and how people actually behave in practice.

It is notable that perceptions about the appropriateness of a particular behaviour depend not only on the social position and culture of the perceiver, but also on the *age* of the person performing the behaviour. 'Age norms' may be descriptive (e.g. the typical age at which a behaviour becomes commonplace, or a life transition occurs) or injunctive (e.g. social expectations about age appropriate behaviour, or the age at which a life transition *ought* to occur). A characteristic of all the outcomes of interest – smoking, cannabis use, binge drinking

and sexual activity – is that the dominant culture[18] deems them socially unacceptable in children. They differ in the extent to which they are socially acceptable in adults: sexual activity is completely accepted in adults, within certain boundaries, which have liberalised dramatically over recent decades (Mercer et al. 2013, Twenge et al. 2015, Daugherty & Copen 2016). Smoking was once completely accepted in adults (at least among men) but has become increasingly socially unacceptable in the dominant culture of most high-income countries over the past 30 years (Chapman & Freeman 2008, Cummings 2016). In contrast, attitudes to recreational cannabis use have become *more* accepting in recent years than they were in previous decades (Duff et al. 2012, Carliner et al. 2017). However, despite growing social acceptability and decriminalisation/legalisation in some parts of the world, at the time of writing recreational cannabis use remains illegal for people of any age in New Zealand. The social acceptability of binge drinking differs in different cultures (e.g. historically it has been more acceptable for men than women and in traditional beer drinking cultures compared with wine drinking cultures). However it is generally more common and socially acceptable in young adults than in adolescents or mature adults (Britton et al. 2015).

There is international evidence that age norms for the initiation of substance use and sex may be changing, playing a direct role in observed declines in prevalence of risk behaviours in adolescents (particularly those aged under 16) since the turn of the century. Most of this evidence comes from the USA, showing that initiation of smoking (Terry-McElrath & O'Malley 2015) and cannabis use (Grucza 2017) is increasingly occurring in young adulthood rather than in adolescence, and that age of sexual debut has risen in recent years, after decades of decline (Finer & Philbin 2013).

Chapter overview

This chapter has three parts. Part 1 focuses on age of initiation, that is, the typical age at which students report smoking, cannabis use, drinking alcohol and having sexual intercourse for the first time. It tests whether the age of initiation for these risk behaviours has increased over the study period, which would indicate a change in descriptive age norms.

[18] I refer here to the dominant culture of English-speaking countries, which tends to be dictated by the norms and values of White, middle-class adults. As noted previously, different cultures, social groups and age groups may have different views on the age at which alcohol use, sexual intercourse etc. are acceptable. For example, introducing children to wine as part of the family meal is the norm in some cultures, and research shows that, at the country level, age norms for timing of sexual initiation differ widely between high-income countries (Madkour et al, 2014).

Part 2 explores students' attitudes about the acceptability of substance use (smoking, drinking and cannabis use) among people their own age, which can be seen as a measure of injunctive norms. It investigates changes in adolescents' attitudes over time and the extent to which they explain declines in risk behaviour over the 2001-2012 period. Parts one and two are linked by the concept of age norms, that is, informal social rules about age-appropriate behaviour.

Part 3 investigates the possible contribution of parental modelling, important for the intergenerational transmission of social norms as discussed above. It addresses two questions: has prevalence of parental substance use changed over time, and if so, does this (partially) explain declines in adolescent risk behaviour?

Part 1: Age of initiation

This study investigates descriptive age norms, i.e. the 'typical' age at which students report smoking, drinking, using cannabis and having sexual intercourse for the first time. The aim is to investigate empirically whether onset of these behaviours is occurring later in more recent New Zealand cohorts. If so, then the observed decline in risk behaviour prevalence in 13-15 year olds is partially explained by this delay in initiation.

The approach used in this study is different from the other Youth 2000 analyses included in my thesis. This is because the Youth 2000 surveys includes secondary students of various ages, and therefore the amount of time at risk of initiating risk behaviours differs between participants. In this situation survival analysis (also known as 'time to event' analysis) is an established method for determining differences between groups (in this case, survey years) in 'time to event' (in this case, time between birth and initiation of each risk behaviour).

Research question

- Has the mean and median age of initiation for smoking, drinking, using cannabis and sexual intercourse (i.e. the age at which these behaviours are engaged in for the first time) increased over the study period?

Methods

Data and participants

This study used data from the Youth 2000 study, and included the full sample (i.e. not restricted to the under-16 age group). Details of the survey's sampling design and data

collection methods are provided in the previous chapter, and characteristics of the sample are presented in Table 34. As shown, the age structure of the sample has changed slightly over time, due to students staying at school longer on average in more recent years.

Table 34: Youth 2000 participant characteristics, by year (full sample)

		2001		2007		2012	
		n	%	n	%	n	%
Total		9567	100	9107	100	8500	100
Sex	**Male**	4414	46.6	4911	54.1	3874	45.7
	Female	5152	53.4	4187	45.9	4623	54.3
Age	**13 or under**	2050	21.8	1860	20.3	1838	21.6
	14	2285	23.9	2101	23.0	1896	21.1
	15	2178	22.8	1973	21.8	1755	20.7
	16	1725	17.9	1743	19.2	1578	18.6
	17+	1308	13.5	1423	15.7	1422	16.8
Ethnicity	**Euro/ Other**	5636	59.2	5328	58.5	4535	53.3
	Māori	2340	24.5	1702	18.7	1701	20.0
	Pacific	768	8.4	924	10.2	1201	14.3
	Asian	679	7.9	1126	12.5	1051	12.4
School Decile	**High**	3554	35.4	3123	35.8	3411	40.1
	Med	4546	49.5	4375	49.5	3296	40.0
	Low	1467	15.2	1298	14.7	1793	20.9

Note: proportions are weighted to adjust for the complex sampling design

Variables

Age of initiation

For substance use, analysis was restricted to 2007 and 2012 because comparable age of initiation data was not available for 2001 for tobacco, alcohol or cannabis use.

In all three survey years, age of initiation for smoking was based on the question: 'About how old were you when you first smoked a whole cigarette?' For alcohol, it was based on the question: 'How old were you when you had your first drink of alcohol, not counting a few sips?' (Note that data on age at which drunkenness or binge drinking first occurred was not available). For cannabis, age of initiation was based on the question: 'How old were you when you had your first smoke of marijuana?' In 2007 and 2012, answer categories were 9 or under, 10, 11, 12, 13, 14, 15, 16, over 16, and 'I don't remember'. In 2001 answer categories were less than 5, 5 to 9, 10 to 12, 13 to 15, older than 15, and 'I don't remember'. Because the

answer categories in 2001 were much broader, were not comparable with 2007 and 2012, and do not allow for fine-grained analysis, the survival analysis for substance use was based on 2007 and 2012 data only.

For sexual intercourse, age of initiation was based on the question: 'How old were you when you first had an experience of sex? (by this we mean sexual intercourse or going all the way).' It is important to note that in 2012 – but not in previous surveys – sexual abuse was explicitly excluded ('Do not include sexual abuse'), creating inconsistency in the question wording between surveys. Answer categories were grouped: '11 or under', 12, 13, 14, 15, 16, 17 or 18+ for all three survey years.

For survival analysis, two variables were created for each of the outcomes of interest: an 'event 0/1' variable based on whether or not the behaviour of interest had ever occurred; and a 'time until event' variable, which was equal to age for those who had never engaged in the behaviour, and was equal to age of initiation for those who had.

Analysis

Survival analysis was used to determine whether age of initiation differed between survey years. The SAS procedure PROC LIFETEST was use to plot a Kaplan-Meier 'survival curve' showing the percentage remaining abstinent versus time for each risk behaviour by survey year. The procedure also produced a weighted mean age of initiation for each survey year, which takes into account the proportion 'censored' (i.e. the proportion who had not yet engaged in the behaviour, at the time of the survey). Further, the age by which 25% and 50% of secondary students were estimated to have initiated (based on the Kaplan-Meier survival curve) was also calculated, where those thresholds were reached. Because the mean may be skewed by extreme values and proportion 'censored', these lower quartile and median measures may give a more valid measure of descriptive norms and how they have changed over time. For this reason, the median (rather than the mean) is more commonly used as a summary statistic for the Kaplan-Meier survival estimate (Barker 2009).

To test whether age of initiation differed between survey years, Cox's regression (PROC PHREG) was used to estimate a hazard ratio between the reference year (2007 for substance use; 2001 for sexual intercourse) and subsequent survey years. A hazard ratio significantly different from 1 would indicate a difference between survey years in age of initiation, with a number below 1 indicating a significant increase in age of initiation.

In addition to the main analysis described above, which compared the survey years as a whole, I also undertook supplementary analyses stratifying the findings by *age at survey* for each risk behaviour and survey year. This was to address possible bias caused by the changing age structure of the sample over time and also enabled more fine-grained analysis of descriptive norms by age.

Results

The results of the main analysis are presented in Table 35. The findings show that for all four behaviours, the (weighted) mean age of initiation increased between 2007 and 2012 ($p<.0001$), and the proportion who had never engaged in the behaviour also increased for all four risk behaviours between 2007 and 2012.

The mean age of sexual debut fell in the first half of the study period, from 16.3 in 2001 to 16.1 in 2007, before rising to 16.7 in 2012 (Table 35). This corresponds with the increase in the proportion of secondary school students reporting they had ever had sex in the first half of the study period, followed by a decline in the second half of the study period.

Table 35: Kaplan-Meier survival estimates, showing mean and median age of initiation by survey year

	Survey Year	N	Mean age of initiation (weighted)	25th percentile*	50th percentile*	% of sample reporting no experience (yet) at time of the survey
Tobacco use	2007	8 246	15.5	14	-	68%
	2012	8 129	16.0	16	-	77%
Cannabis use	2007	7 866	15.2	15	-	73%
	2012	8 044	16.2	16	-	78%
Alcohol use	2007	8 151	13.9	13	14	29%
	2012	8 047	14.6	13	15	44%
Sexual intercourse	2001	9 053	16.3	15	17	68%
	2007	8 064	16.1	15	17	64%
	2012	8 211	16.7	16	-	76%

**Based on Kaplan-Meier survival estimates. A dash (-) indicates the 50% percentile was not reached*

Based on the Kaplan-Meier survival estimates (Table 35), the age by which 25% of secondary students were estimated to have smoked a whole cigarette, used cannabis and had sexual intercourse increased between 2007 and 2012. For alcohol, the age by which 25% were estimated to have initiated use did not change, but the age by which 50% were estimated to

have drunk alcohol increased markedly between 2007 and 2012. For sexual intercourse 50% were estimated to be sexually experienced by 17 years of age in 2007, but in 2012 the 50% threshold was not reached.

As previously noted, however, the slightly differing age structure across survey years may affect the validity of the comparison over time. Stratification by age was conducted to test this possibility. Survival curves for each behaviour (based on the main analysis), and results stratified by age are presented below.

Tobacco smoking

Figure 51 shows the results of the main analysis graphically, with a marked increase in age of initiation observable between 2007 and 2012 (hazard ratio 0.68, 95% CI 0.64 to 0.72, p<.0001).

Figure 51: Kaplan-Meier survival curve for tobacco initiation, 2007 & 2012

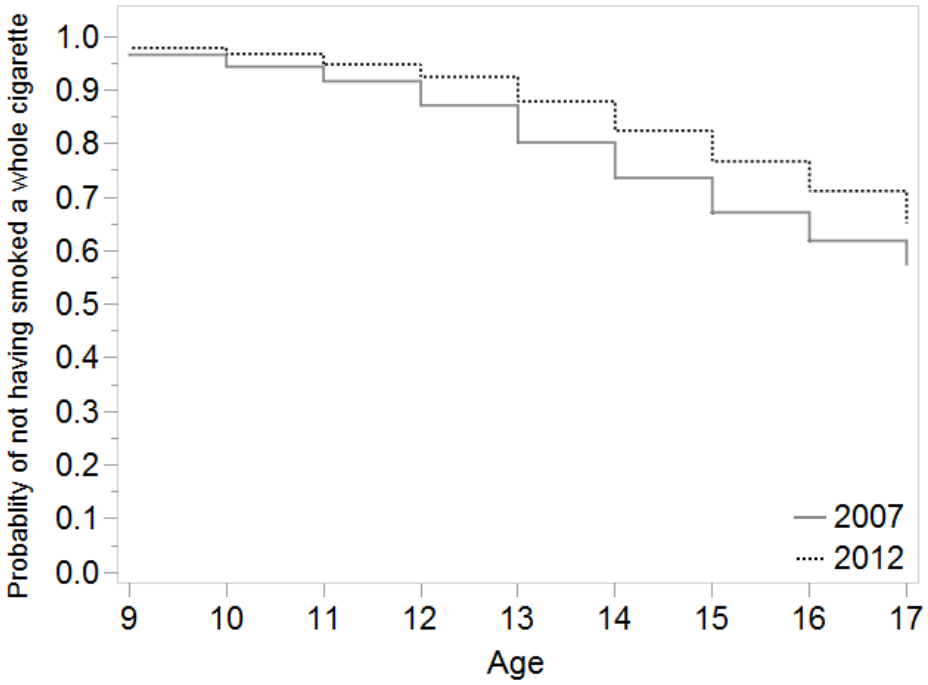


Table 36 provides results stratified by age, and confirms the findings of the main analysis. It shows that for each age at survey, (weighted) mean age of smoking initiation increased, and the proportion who had never smoked also increased. The difference between survey years was statistically significant for every age strata (p<.0001), as indicated by hazard ratios that differ from 1. The greatest change over time was seen among younger students.

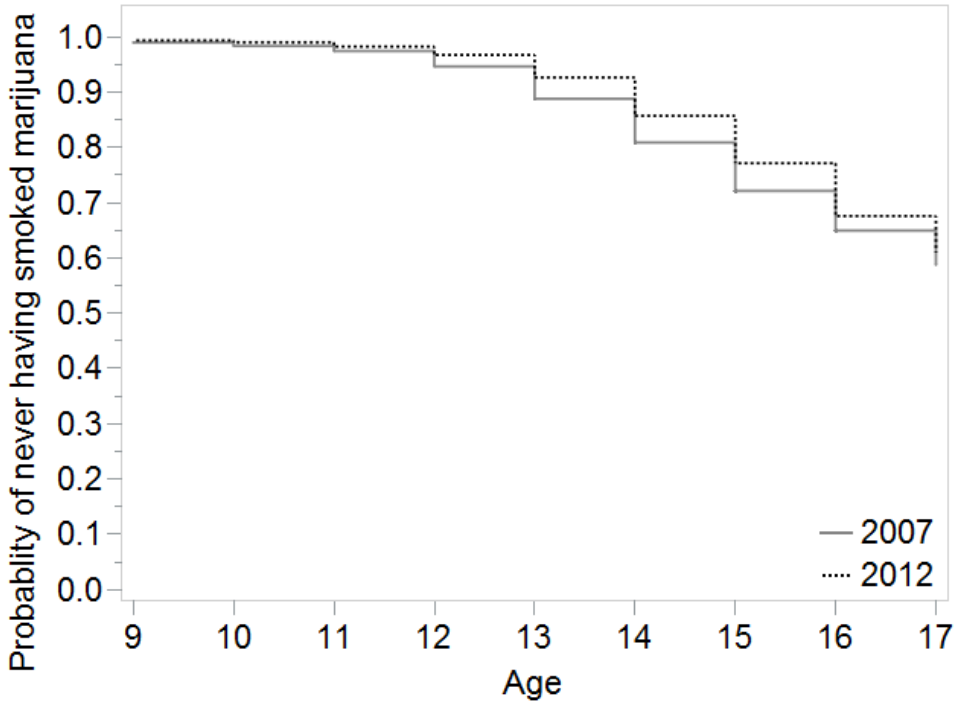
Table 36: Age at first tobacco use, survival analysis stratified by age, 2007 & 2012

	2007			**2012**			**Difference between survey years**	
Age at survey	N	Mean age of initiation	% no experience (yet) at time of survey	N	Mean age of initiation	% no experience (yet) at time of survey	Hazard ratio 2012/2007	P value
13	1651	12.65	80.3%	1757	12.81	88.2%	0.58 (0.48, 0.69)	<.0001
14	1881	13.39	71.0%	1834	13.60	81.6%	0.60 (0.53, 0.69)	<.0001
15	1803	14.16	65.5%	1660	14.48	75.5%	0.66 (0.58, 0.75)	<.0001
16	1591	14.94	61.8%	1506	15.27	68.3%	0.78 (0.69, 0.88)	<.0001
17+	1314	15.93	62.4%	1364	16.28	69.8%	0.75 (0.66, 0.86)	<.0001

Cannabis use

As shown in Figure 52, there was a statistically significant increase in age of cannabis initiation between 2007 and 2012 based on the main analysis (hazard ratio 0.83, 95% CI 0.77 to 0.88 p<.0001).

Figure 52: Kaplan-Meier survival curve for cannabis initiation, 2007 & 2012



However the age-stratified results (Table 37) show that increases between 2007 and 2012 in (weighted) mean age of cannabis initiation were only statistically significant among younger adolescents (aged 13-15).

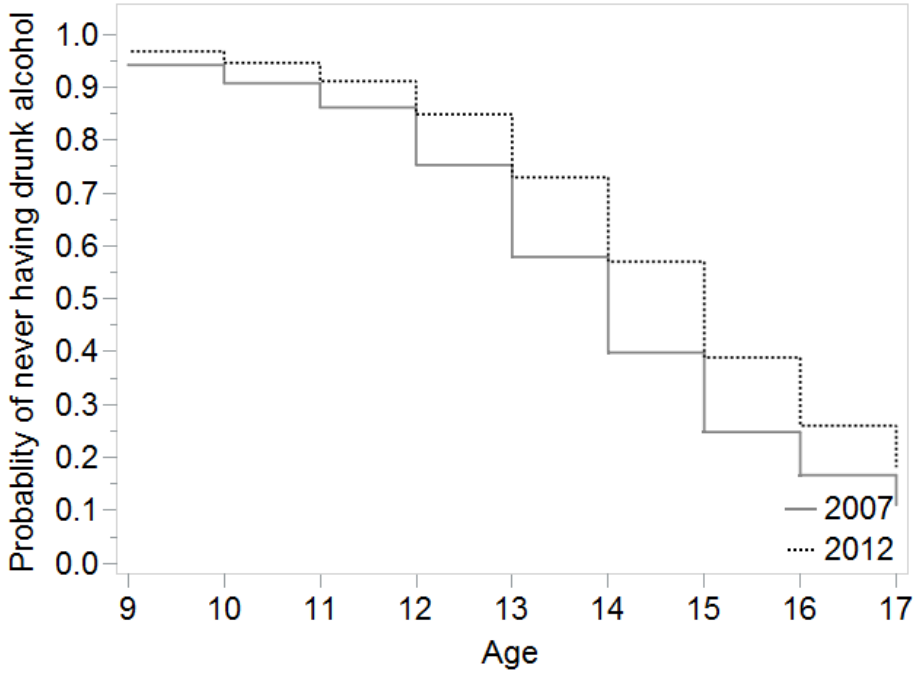
Table 37: Age at first cannabis use, survival analysis stratified by age, 2007 & 2012

	2007			**2012**			**Difference between years**	
Age at survey	N	Mean age of initiation	% no experience (yet) at time of survey	N	Mean age of initiation	% no experience (yet) at time of survey	Hazard ratio 2012/2007	P value
13	1568	12.87	86.9%	1735	12.92	92.4%	0.57 (0.46, 0.71)	<.0001
14	1784	13.70	77.6%	1805	13.80	84.1%	0.69 (0.59, 0.80)	<.0001
15	1706	14.53	70.1%	1648	14.68	76.0%	0.77 (0.67, 0.88)	<.0001
16	1535	15.42	66.3%	1491	15.48	66.5%	0.98 (0.87, 1.12)	0.73
17+	1266	16.29	64.3%	1356	16.42	64.7%	0.96 (0.84, 1.09)	0.54

Alcohol use

As shown in Figure 53, there was a marked increase in the age at which adolescents first drank alcohol (more than a few sips) between 2007 and 2012 (hazard ratio 0.68, 95% CI 0.66 to 0.71, p<.0001). Based on the survival estimates in the main analysis, the age at which 75% of adolescents were estimated to have tried alcohol was 15 years in 2017; in 2012 it had increased to 17 years.

Figure 53: Kaplan-Meier survival curve for alcohol initiation, 2007 & 2012



Results stratified by age are presented in Table 38, and confirm the findings of the main analysis. Mean age of initiation increased between 2007 and 2012 in each 'age at survey' group, and the proportion who had not tried alcohol at the time they were surveyed increased substantially, particularly among 13-15 year olds. The difference in survival curves between 2007 and 2012 was statistically significant for each age strata.

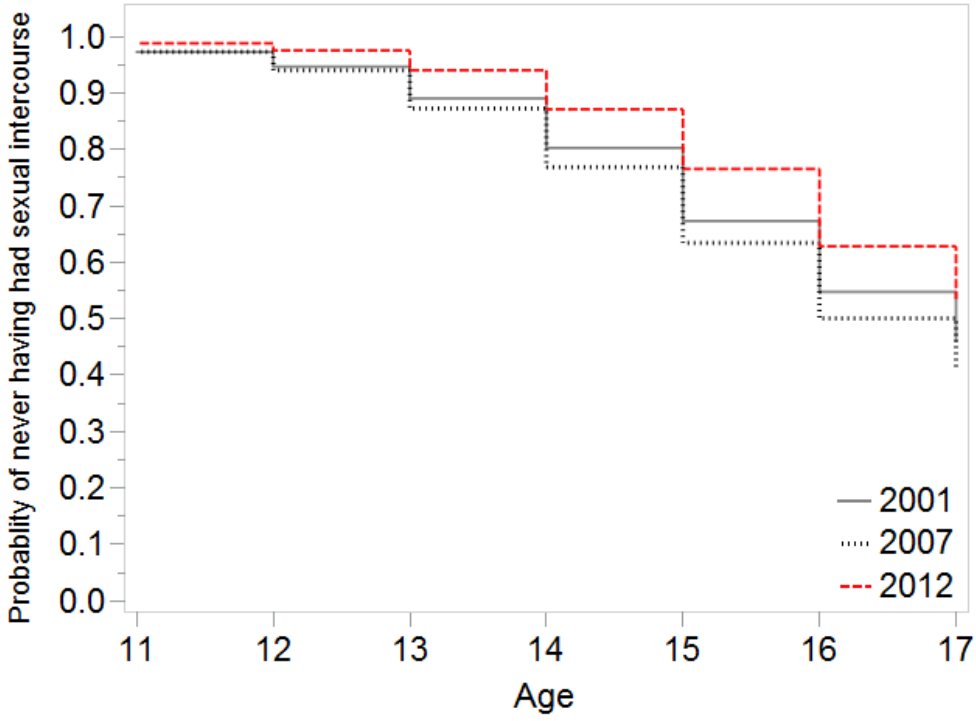
Table 38: Alcohol initiation, survival analysis stratified by age, 2007 & 2012

	2007			**2012**			**Difference between years**	
Age at survey	N	Mean age of initiation	% no experience (yet) at time of survey	N	Mean age of initiation	% no experience (yet) at time of survey	Hazard ratio 2012/2007	p-value
13	1644	12.29	49.9%	1740	12.64	71.7%	0.50 (0.45, 0.56)	<.0001
14	1860	12.83	34.4%	1812	13.27	53.6%	0.61 (0.55, 0.66)	<.0001
15	1768	13.43	24.7%	1649	13.87	39.4%	0.70 (0.64, 0.76)	<.0001
16	1567	13.89	17.2%	1486	14.43	25.8%	0.74 (0.69, 0.81)	<.0001
17+	1303	14.55	14.8%	1344	15.04	19.9%	0.81 (0.75, 0.89)	<.0001

Sexual intercourse

Survival curves for first experience of sexual intercourse are presented in Figure 54, showing statistically significant changes over time based on the main analysis. Age of sexual debut decreased between 2001 and 2007 (hazard ratio 1.15, 95% CI 1.09 to 1.21, 0<.0001) before increasing substantially between 2007 and 2012 (hazard ratio 2012/2001 0.72, 95% CI 0.68, 0.76, p <.0001).

Figure 54: Kaplan-Meier survival curve for sexual debut 2001-2012



These findings were confirmed in the results stratified by age shown in Table 39. The mean age of sexual debut increased between 2001 and 2012 in all age strata, and the proportion who had not yet had sex at the time they were surveyed also increased in all age strata. The differences between 2001 and 2012 were statistically significant for all age strata except 17+, with a clear age gradient in effect size.

Table 39: Age at first sexual intercourse, survival analysis stratified by age, 2001-2012

	2001		2007		2012		Difference between years	
Age at survey	Mean age of initiation	% no experience (yet) at time of survey	Mean age of initiation	% no experience (yet) at time of survey	Mean age of initiation	% no experience (yet) at time of survey	Hazard ratio 2007/2001	Hazard ratio 2012/2001
13	12.88	84.0%	12.84	80.35	12.95	92.7%	1.24* (1.46, 1.06)	0.44* (0.36, 0.54)
14	13.73	75.2%	13.74	73.0%	13.88	86.2%	1.09 (0.97, 1.24)	0.53* (0.46,0.62)
15	14.63	66.8%	14.52	60.9%	14.75	76.4%	1.23* (1.10, 1.36)	0.68* (0.77, 0.60)
16	15.45	58.4%	15.38	53.9%	15.57	63.5%	1.14* (1.03, 1.27)	0.84* (0.75, 0.94)
17+	16.21	51.4%	16.08	46.7%	16.29	54.7%	1.15* (1.03, 1.28)	0.92 (0.82, 1.03)

**Statistically significant difference between survey years, p<.05*

As previously noted the question about age at first sex explicitly excluded sexual abuse in the 2012 survey, but not in previous surveys. The extent to which this change explains the observed rise in age of debut and decrease in sexual experience between 2007 and 2012 is unknown. However it is notable that a decline of a similar magnitude occurred in *current* sexual activity between 2007 and 2012 (which explicitly excluded sexual abuse and unwanted sex in both 2007 and 2012 surveys) suggesting real declines in consensual sexual behaviour occurred over this period (Clark et al. 2016). Therefore the changes observed in the age of sexual debut between 2007 and 2012 are likely to reflect real changes, though they may be somewhat overstated due to the change in question wording.

Discussion

This study provides clear evidence of statistically significant increases in age of initiation for smoking, drinking, cannabis use and sexual intercourse. These increases were minor for cannabis (and only statistically significant for students aged under 16), but substantial for smoking, drinking and sexual intercourse. Based on this finding, it is self-evident that the observed declines in the prevalence of substance use and sexual activity in 13-15 year olds in New Zealand were partially a result of increasing age of initiation. While this does not provide a *causal* explanation for declining risk behaviour in this age group, evidence of increasing age of initiation does help us to understand why school-based surveys have observed such dramatic declines in adolescent risk behaviours in recent years.

I have only identified one published study that examined recent trends in age of substance use initiation, and its results were consistent with those presented above. It was based on Monitoring the Future data (1976-2015) from the USA, and demonstrated an increase since 2000 in the average school grade at which students reported using cigarettes, alcohol and cannabis for the first time (Keyes et al. 2018). The increase in age of initiation was greatest for tobacco, and smallest for cannabis. Preliminary findings from Australia based on repeat cross-sectional data from the National Drug Strategy Household Survey also shows that among 18-21 year olds who reported alcohol, tobacco or cannabis use, mean age of initiation increased significantly between 2001 and 2016 for all three substances, with tobacco showing the biggest absolute change (Livingston 2019). These findings are also consistent with previous New Zealand and international research showing that smoking initiation in young adulthood (age 18-24 years) has become increasingly common in recent years (Edwards et al. 2013, Terry-McElrath & O'Malley 2015). Similarly, the initiation of cannabis use in young adulthood in the USA has increased in recent years, corresponding with decreasing use during adolescence (Grucza 2017).

Rising age of initiation appears to be good news from a public health perspective, since (as discussed in Chapter 2) early age of initiation is consistently associated with greater likelihood of long term health and social harms. If indeed there is a causal relationship between early age of initiation and harms such as substance dependency, psychosis and other mental health problems, school failure, adolescent pregnancy, and sexually transmitted infections, we would expect to see declining prevalence of all of these negative outcomes in 'late initiating' cohorts as they mature (other things being equal). US research has demonstrated that later initiation of sexual intercourse played a role in the decline in teen pregnancy in that country in the 1990s (Flanigan 2001, Santelli et al. 2004) but empirical confirmation of other health and social benefits of delayed substance use and sexual debut remains an area for future research.

If and where declines in substance use are carried through to adulthood, the public health impacts are likely to be even more profound, since many of the harms associated with tobacco, alcohol and cannabis accrue due to long term use. As discussed in Chapter 3, smoking and drinking appear to have declined in young adults in New Zealand, but in the absence of robust age, period, cohort analysis, it is not yet clear whether we are seeing a generational effect or simply delayed uptake.

While there is clear evidence that the age of initiation has increased over the study period in at least three of the four countries of interest, the *reasons* for this international shift are not

entirely clear. As discussed in Chapter 2, there appears to have been a shift in recent decades in the upper boundary of childhood, in parallel with later transition to adult roles such as getting a drivers licence, leaving school and getting a job. More protective and involved parenting, and the popularisation of the idea that brain maturity is not achieved until the mid-20s may also have contributed to shifts in how adolescents are treated, and how they see themselves (i.e. more like children, and less like adults).

The strengths and limitations of the study must be borne in mind when interpreting the results. A strength is that the time elapsed between first use of substances/experience of sexual intercourse and survey completion is short (compared with adult samples), and therefore recall bias is unlikely to be problematic. Even when reported retrospectively by adults, self-reported age of onset of tobacco, alcohol and illicit drug involvement has been shown to be reasonably reliable (Parra et al. 2003). Age stratified analyses showed that the slight change in the age structure of the sample between surveys did not affect results meaningfully, but highlighted that rising age of cannabis initiation was limited to those aged under 16. A limitation is that there were only two available time points for substance use. Because respondents were aged between 13 and 17 at the time of the survey, many were not yet of the age at which we would expect risk behaviour to begin. This does not affect comparability between survey years (which was the purpose of the study), but means that the age of initiation findings are underestimates of the mean age of onset within each birth cohort (i.e. only by surveying people in adulthood can 'true' estimates be established). As previously noted, methodological changes may have affected the comparability between years of the 'age at first intercourse' variable, and therefore findings about increasing age of sexual debut since 2007 should be treated with caution. However they are consistent with US findings (Finer & Philbin 2013, Finer & Philbin 2014).

Because the amount of time participants were at risk of initiating risk behaviours differs according to age at survey, it was not possible to derive an 'age of initiation' variable for each participant that could be entered as a predictor in regression models. Therefore it was not possible to quantify the extent to which increasing age of intitiation explains trends in adolescent risk behaviour, or its relative importance compared with the other predictors tested.

In summary, my findings add to growing international evidence of rising age of initiation for substance use and sexual intercourse since the early 2000s. On average, adolescents of the 21st century in many high-income countries are having their first experience of smoking,

drinking, using cannabis and sexual intercourse later in life than their late 20th century counterparts. This has undoubtedly contributed to the observed decline in adolescent risk behaviour in 13-15 year olds, though the reasons for rising age of initiation are unclear.

Part 2: Student attitudes to substance use

Much health promotion action (and also commercial advertising, political campaigning, etc) rests on the premise that changing people's beliefs, attitudes or feelings will lead to a change in behaviour. This idea is formalised in many of the theories that underpin health promotion (Rimer & Glanz 2005), including, for example, the theory of reasoned action (Fishbein & Ajzen 1975), and the theory of planned behaviour (Ajzen 1985). Empirical research has validated the predictive power of these theories, with attitudes consistently predicting subsequent behaviour, under certain conditions (Kraus 1995, Armitage & Conner 2001). This finding is consistent with findings from adolescent research showing a strong association between *acceptability* and *use* of particular substances at both individual and population levels (Kumar et al. 2002, Johnston et al. 2016).

However, research has demonstrated that causality can also run in the opposite direction: from behaviour to attitudes. For example, a Dutch longitudinal study of adolescent smoking attitudes and behaviour found a bi-directional relationship between the two, with smoking behaviour shaping subsequent smoking attitudes more strongly and consistently than vice versa (de Leeuw et al. 2008). Similarly longitudinal data from the USA show that there is a bi-directional (negative) association between use of cannabis and perceived harmfulness of cannabis use (Salloum et al. 2018). That is, those who do not perceive cannabis use as harmful are more likely to become users, and those who use cannabis are less likely to consider it harmful.

The influence of behaviour on attitudes has also been formalised in theory: cognitive dissonance theory predicts that when attitudes and behaviours are discordant, an individual will generally try to reduce this dissonance, for example by adjusting their attitudes (Festinger 1962). Bem's self-perception theory, developed as an alternative explanation for Festinger's empirical findings, states that people develop attitudes and opinions partially from observing their own behaviour (Bem 1972). Bem's theory may be particularly applicable to adolescent risk behaviour, since adolescents are in the life stage of developing their own attitudes in the context of conflicting messages about substance use and sexuality (e.g. from popular culture,

peers, parents and teachers). For some young people, it may be by observing their own behaviour that they crystallise their opinions.

This study focuses on the relationship between student attitudes (i.e. injunctive norms) and behaviours, and how attitudes to substance use have changed over time in New Zealand. It investigates attitudes to substance use in different age groups and what this suggests about changing age norms. Finally it explores the extent to which changing student attitudes towards substance use account for declines in adolescent smoking, drinking, cannabis use and sexual activity between 2001 and 2012. (Note that data on attitudes to sexual activity were not available.)

Research questions

- Is there an association between the perceived acceptability of substance use among New Zealand adolescents and smoking, drinking, cannabis use and sexual behaviour in this population?
- Has acceptability of substance use changed over the course of the study period among adolescents?
- Do attitude changes over time differ by age group or by substance use status?
- To what extent do changing attitudes account for the declining trends in risk behaviour indicators in this population?

Methods

Data and participants

This study is based on the same data as Chapter 6: nationally representative repeat cross-sectional data from the Youth 2000 surveys conducted in 2001, 2007 and 2012. Details about the sampling method, response rate, and administration of the survey were provided in the previous chapter. The main analysis was restricted to students aged less than 16 years of age, and participant characteristics for this group are provided in Chapter 6. However the analysis of attitude change by age includes the full Youth 2000 sample. Participant characteristics of the full sample were provided in Table 34, in Part 1 above.

Variables

The outcome variables were:

- Past month tobacco smoking
- Past month cannabis use

- Past month binge drinking, defined as 5+ drinks in a session, at least once in past month
- Sexually active, defined as having sexual intercourse at least once in last 3 months.

These outcome variables were identical to those used in Chapter 6, and details are available in that chapter.

Attitudes to substance use were based on the question: 'Which of these do you think it is okay for people your age to use regularly?' Respondents answered 'yes' or 'no' to each of the following: 1) 'cigarettes, tobacco' 2) 'alcohol (e.g. beer, wine, spirits, etc)' 3) 'marijuana (e.g. cannabis, weed, pot, hash, grass etc)'. A dichotomous variable was created for each of the three substances. Note that questions about the acceptability of sexual behaviour were not included in the Youth 2000 survey.

Demographic variables

Demographic variables were:

- Age: 13 or under, 14, 15, 16, 17+
- Sex: M, F
- School decile: 1-10
- Prioritised ethnicity: Māori, Pacific, Asian, Euro/Other

Again, these are identical to the previous study, with details available in Chapter 6.

Analysis

First, to confirm that the attitudinal variables were associated with the outcomes of interest, bivariate associations between each attitude variable and each outcome were calculated using logistic regression. All models were adjusted for age, sex, school decile and ethnicity, and results were expressed as odds ratios (OR) and 95% confidence intervals (CI).

Next, trends in attitudes to substance use were explored using descriptive statistics to calculate the proportion that reported 'It's OK for people my age to use tobacco/alcohol/marijuana regularly' for each survey year. To explore whether reverse causation accounted for changing attitudes (i.e. acceptability of substance use declined because fewer adolescents were using substances), trends were also analysed by substance use status. Users were defined as those who used the substance monthly or more often. To further explore the age norm component of the question, attitudinal trends were analysed by

age and age group (under 16 years, 16+ years), using the full Youth 2000 sample (i.e. not restricted to younger adolescents, as for the main analysis).

Finally, trend analyses were conducted using logistic regression. To test the extent to which attitudes to substance use accounted for the change over time in outcomes, I modelled each outcome (prevalence of past month smoking, past month cannabis use, past month binge drinking and proportion sexually active in the past 3 months) as a function of survey year. This model was adjusted for demographic factors (age, sex, ethnicity and school decile), and included school ID as a random effect to account for clustering at the school level. This was Model 1, the base model. I then added the attitudinal variables to Model 1, first individually then collectively. Significant attenuation of the OR for year, which was tested using Z tests to compare log odds, would indicate that the attitudinal variable (partially) accounted for the trend over time.

To further test the 'reverse causality' hypothesis (i.e. that declining risk behaviour led to attitude change rather than vice versa) a supplementary analysis was conducted. This involved modelling the attitudinal variables as outcomes (OR for year, adjusted for age, sex, ethnicity and school decile), and investigating how the addition of the risk behaviour variables to the model affected attitudinal trends.

All analyses were adjusted for the weighting and clustering in the complex sampling design, and were conducted using PROC SURVEYFREQ and PROC GLIMMIX in Version 9.4 of the SAS system for Windows.

Results

Is there an association between attitudes to substance use and risk behaviours?

As shown in Table 40, analysis revealed very strong relationships between attitudes to substance use and all four risk behaviours, after adjusting for demographic factors. For example, those who perceived tobacco smoking to be acceptable were about 15 times more likely (OR 15.63) to have smoked in the past month than those who reported smoking to be unacceptable, and there was a similar relationship between attitudes to and use of cannabis (OR 16.58).

Table 40: Associations between attitudes to substance use and risk behaviours, 2001- 2012 (pooled)

	Past month smoking	Past month cannabis use	Past month binge drinking	Sexually active
It's OK for people my age to smoke tobacco regularly Ref = disagree	15.63 (14.71, 16.60)	7.79 (7.37, 8.23)	6.38 (6.10, 6.68)	5.17 (4.92, 5.43)
It's OK for people my age to smoke cannabis regularly	8.05 (7.59, 8.55)	16.58 (15.62, 17.60)	8.11 (7.67, 8.57)	5.83 (5.52, 6.15)
It's OK for people my age to drink alcohol regularly	4.75 (4.50, 5.03)	5.03 (4.76, 5.31)	7.05 (6.78, 7.34)	3.69 (3.53, 3.86)

All associations are adjusted for age, sex, ethnicity and school decile

The relationship between the perceived acceptability of regular alcohol use and binge drinking was strong (with those condoning regular drinking approximately 7 times more likely to have engaged in binge drinking in the past month), but not as strong as the relationship between attitudes and behaviour for tobacco and cannabis smoking. This may be due to weaker correspondence between the attitudinal factor (regular alcohol use) and the outcome variable (binge drinking), i.e. some students may condone regular drinking but not binge drinking.

As discussed in Chapter 2, risk behaviours tend to cluster. There are risk factors that make young people vulnerable to risk behaviours in general, and engagement in one risk behaviour increases the likelihood of engaging in others. Therefore it is not surprising that attitudinal variables were not only strongly related to the corresponding behaviour (e.g. smoking attitudes to smoking behaviour) but also to the other outcomes, including sexual activity. For example, likelihood of being sexually active was strongly associated with permissive attitudes towards tobacco smoking (OR 5.17), cannabis use (OR 5.83), and (to a lesser extent) alcohol use (OR 3.69), indicating that those with permissive attitudes to substance use were much more likely to be sexually active than those who did not condone substance use in adolescents their own age. Similarly, permissive attitudes to one substance was associated with use of the other two substances. To further explore these cross-relationships, I looked at the relationship between attitudes and outcomes, adjusting for the other attitudinal factors as well as demographic factors. The results are shown in Table 41.

Table 41: Adjusted associations between attitudes to substance use and risk behaviours, 2001-2012 (pooled)

	Past month tobacco use	Past month cannabis use	Past month binge drinking	Sexually active
It's OK for people my age to smoke tobacco regularly Ref = disagree	11.38 (10.55, 12.29)	2.46 (2.28, 2.64)	2.21 (2.09, 2.34)	2.53 (2.37, 2.69)
It's OK for people my age to smoke cannabis regularly	2.29 (2.13, 2.47)	8.85 (8.22, 9.54)	2.40 (3.78, 4.16)	2.53 (2.37, 2.70)
It's OK for people my age to drink alcohol regularly	0.94 (0.87, 1.01)	1.26 (1.17, 1.36)	3.97 (3.78, 4.16)	1.73 (1.63, 1.83)

All associations are adjusted for age, sex, ethnicity, school decile, and attitudes to other substances.

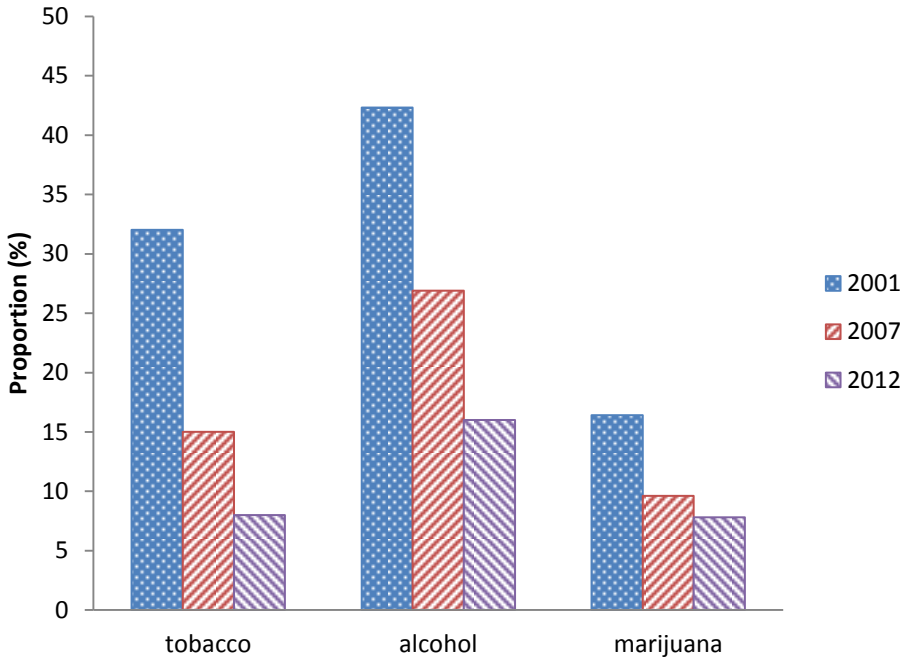
The strength of association decreased markedly after adjustment for other attitudinal factors, suggesting that attitudes are highly correlated. For example, in the partially adjusted model (Table 40) those who condoned regular drinking were almost 5 times as likely to smoke as those who did not condone drinking (OR 4.75, 95% CI 4.50, 5.03). However, after adjusting for attitudes to smoking and cannabis as well as demographic factors (Table 41), the relationship between attitude to alcohol and past month tobacco smoking became non-significant. The other 'cross relationships' also reduced but remained statistically significant, with approval of tobacco and cannabis use at least doubling the likelihood of engaging in any of the other risk behaviours.

The behaviour-specific relationships (i.e. the association between attitude to and use of each substance) also decreased in magnitude but remained highly significant after adjustment. After adjustment, those who condoned smoking were 11 times as likely to have smoked in the past month than those who did not; those who condoned cannabis use were nearly 9 times as likely to have used cannabis in the past month; and those who condoned regular drinking were almost 4 times as likely to have engaged in binge drinking in the past month.

Have attitudes to substance use changed over time?

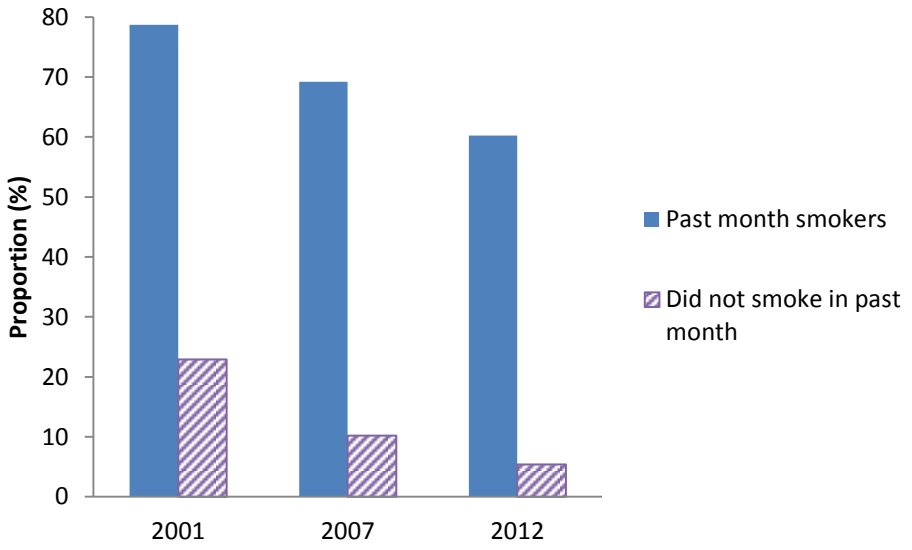
As shown in Figure 55, there was a very substantial shift in students' attitudes towards substance use between 2001 and 2012. The most marked change was in attitudes to tobacco use. Among younger adolescents (aged less than 16) the proportion of respondents who thought it was OK for people their own age to smoke regularly fell by 73% in relative terms, from about a third in 2001 to 8% in 2012. The proportion condoning alcohol use also fell substantially in this age group, from 42% to 16%, while the proportion condoning regular cannabis use halved from 16% to 8%. It is interesting to note that by 2012, the acceptability of tobacco and cannabis was the same in this age group.

Figure 55: Proportion agreeing 'It's OK for people my age to smoke/drink/use marijuana regularly', NZ adolescents aged 13-15 years, 2001-2012



To test whether reverse causality could explain these findings (i.e. whether the change over time in attitudes to substance use could be wholly explained by changing prevalence of substance use), I looked at attitudinal trends in users and non-users of each substance. As shown in Figure 56 the majority of regular smokers condoned smoking in people their own age, whereas very few who were not regular smokers condoned smoking.

Figure 56: Proportion agreeing 'It's OK for people my age to smoke regularly' by smoking status, 2001-2012



Interestingly, approval declined in both groups by 18% in absolute terms between 2001 and 2012 (Fig 56). This suggests that the observed change in attitude to smoking over time is not entirely due to an increasing proportion being in the 'non-smoking' group (and therefore less likely to condone smoking). Rather, approval has declined in the sample as a whole, including among smokers. A similar pattern can be seen for alcohol use (Fig 57) and cannabis use (Fig 58).

Figure 57: Proportion agreeing 'It's OK for people my age to drink alcohol regularly' by drinking status, 2001-2012

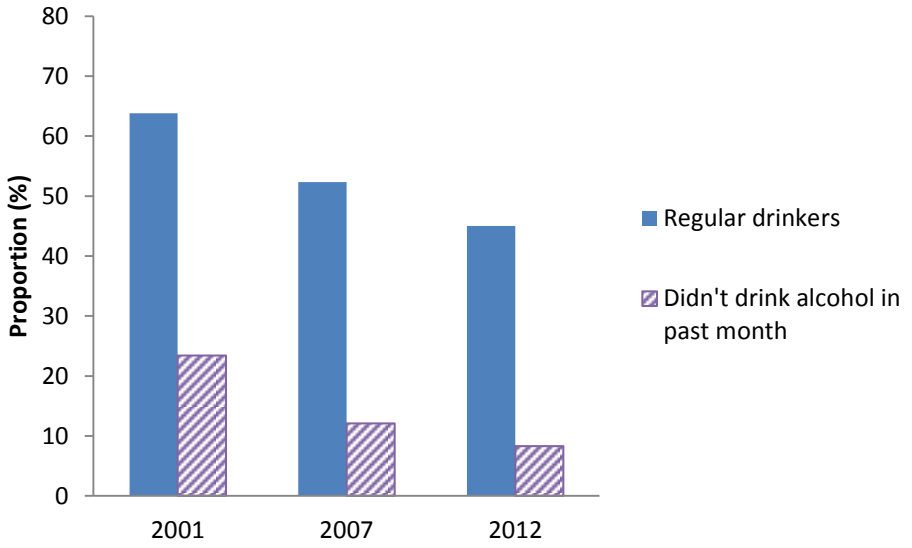
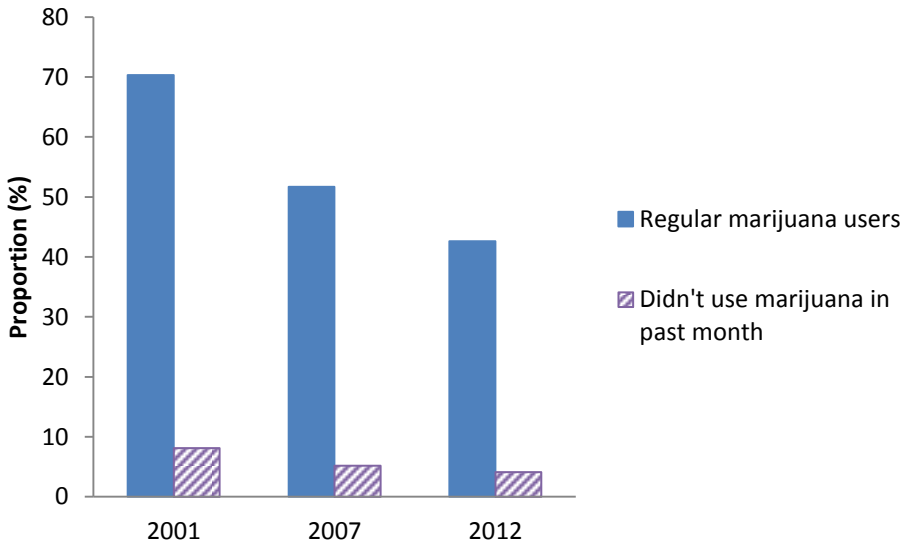


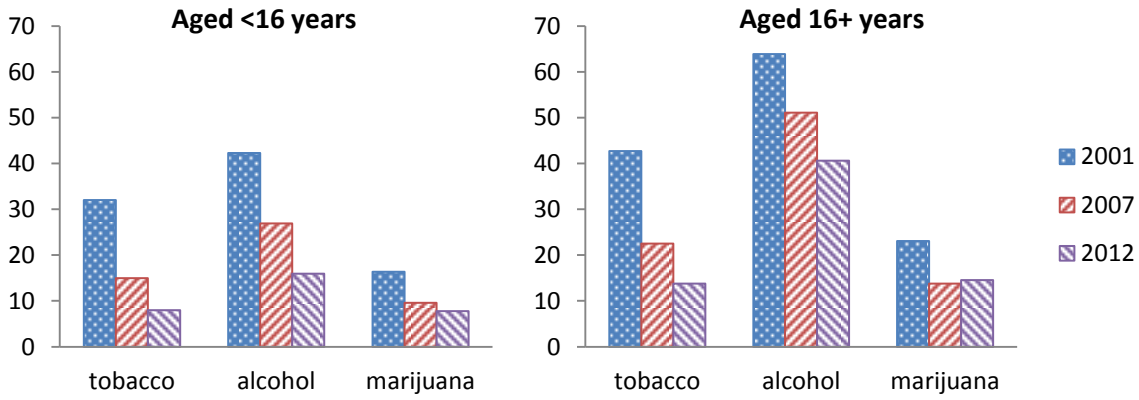
Figure 58: Proportion agreeing 'It's OK for people my age to smoke cannabis regularly' by cannabis use status, 2001-2012



These findings indicate that the observed change in attitudes is not merely a function of declining substance use in this age group.

Students were asked about the acceptability of regular substance use 'for people my age' and therefore the results have an age norm component (i.e. responses combine attitudes about the acceptability of the substance itself and attitudes about the socially acceptable age for use of each substance). Comparing the results for younger versus older adolescents (Fig 9), we can see that perceived acceptability varies markedly with age. For every substance, and in all survey years, the proportion condoning regular use was substantially higher in older compared with younger adolescents. However, the graphs also show that acceptability has declined within both age groups over time, suggesting that there has been a change in attitudes/norms that is independent of age.

Figure 59: Proportion (%) condoning tobacco, alcohol and cannabis use by age group, 2001-2012



Do attitudes account for change over time?

The final component of this study is a trend analysis, testing the extent to which attitudes account for changes over time in the risk behaviours of interest, in statistical terms. Table 42 shows the results of this analysis, showing that attitudes were a major contributor to the downward trends.

Table 42: 2001-2012 trend analysis, testing whether attitudinal variables account for trends in risk behaviours

Year	Model 1: OR for Year Partially adjusted (95% CI)	Model 1 + Attitude to student smoking (95% CI)	Model 1 + Attitude to student drinking (95% CI)	Model 1 + Attitude to student cannabis use (95% CI)	Model 1 + all attitudinal factors combined
	Past month smoking				
2001	1	1	1	1	1
2007	0.48 (0.41, 0.57)	0.77*** (0.65, 0.91)	0.58 (0.49, 0.69)	0.54 (0.46, 0.64)	0.75*** (0.63, 0.88)
2012	0.20 (0.17, 0.23)	0.45*** (0.38, 0.54)	0.28** (0.23, 0.33)	0.22 (0.19, 0.26)	0.42*** (0.35, 0.50)
	Past month cannabis use				
2001	1	1	1	1	1
2007	0.58 (0.48, 0.69)	0.85** (0.70, 1.02)	0.71 (0.59, 0.85)	0.69 (0.58, 0.83)	0.79** (0.66, 0.95)
2012	0.32 (0.26, 0.38)	0.61*** (0.50, 0.73)	0.47** (0.39, 0.56)	0.38 (0.31, 0.45)	0.50*** (0.41, 0.60)
	Past month binge drinking				
2001	1	1	1	1	1

2007	0.77 (0.68, 0.88)	1.04** (0.91, 1.20)	1.03** (0.90, 1.17)	0.87 (0.76, 0.99)	1.13*** (0.99, 1.29)
2012	0.33 (0.29, 0.37)	0.52*** (0.45, 0.59)	0.50*** (0.44, 0.57)	0.36 (0.31, 0.41)	0.55*** (0.48, 0.64)
	Sexually active (past 3 months)				
2001	1	1	1	1	1
2007	1.56 (1.37, 1.78)	2.33*** (2.03, 2.66)	2.01** (1.76, 2.30)	1.97* (1.73, 2.24)	2.41*** (2.11, 2.75)
2012	0.68 (0.60, 0.78)	1.19*** (1.03, 1.36)	0.97*** (0.85, 1.12)	0.84* (0.74, 0.96)	1.20*** (1.04, 1.37)

All analyses are adjusted for age, sex, ethnicity and school decile
**p<.05 **p<.01 ***p<.001 statistically significant difference in OR from Model 1*

The first column shows the trend (OR for year) for each risk behaviour, adjusted for demographic factors (Model 1). The second column shows that when 'attitude to tobacco smoking' is added to the base model, the OR for year is significantly attenuated (i.e. moves closer to 1) for all four risk behaviours in both the 2001-2007 period and the full study period (2001-2012). The third and fourth columns show the respective effects of adding attitudes to drinking and attitudes to cannabis use to Model 1. Attitude to alcohol use also significantly explained declines in smoking, binge drinking cannabis use and sexual activity over the 2001-2012 period (p<.01), whereas attitude to cannabis use did not attenuate the trends for substance use significantly, but helped to explain declining sexual activity over the study period. The final column shows the combined effect of all three attitudinal factors on risk behaviour trends.

The decline in smoking prevalence over the study period was significantly explained by changing attitudes to smoking (p<.001), whilst attitudes to alcohol drinking had a smaller effect (p<.01) and cannabis attitudes only a marginal impact which was not statistically significant. After including all the attitudinal factors in the model, the attenuation was no greater than for smoking attitudes alone, and much of the change in adolescent smoking remained unexplained.

Decreasing acceptability of smoking was the biggest contributor to cannabis trends, explaining most of the downward trend in cannabis use the 2001-2007 period, and making a statistically significant (p<.001) contribution over the full study period. Changing attitudes to alcohol also made a statistically significant (p<.01) impact on trends in cannabis use over the study period, whereas attitude to cannabis use did not. The model including only tobacco attitudes

explained the change in cannabis use over time better than the model with all three attitudinal factors.

Attitudes to smoking and drinking each made similar (and substantial) contributions to the decline in binge drinking over the study period. They fully explained the decline in binge drinking between 2001 and 2007 ($p<.01$) and partially explained the decline over the full 2001 to 2012 period ($p<.001$). Cannabis attitudes did not contribute significantly. The combined effect of the attitudinal factors was greater than for any factor individually, suggesting that attitudes to smoking and drinking each made an independent contribution.

Attitudes to substance use (individually and in combination) all made a statistically significant contribution to the decline in sexual activity over the full study period, with tobacco attitudes the strongest contributor. As noted in the previous chapter, it may be more appropriate to look at declining sexual behaviour based on 2007-2012 data, since the decline in sexual activity is limited to the second part of the study period. The 2007-2012 analysis is shown in Table 43 and shows a similar pattern of results, with tobacco attitudes the strongest contributor. Attitudes to student drinking also significantly attenuated the trend, but attitudes to cannabis use did not contribute in the 2007-2012 period. It is notable that most of the decline in sexual activity remains unexplained when all attitudinal factors are included.

Table 43: 2007-2012 trend analysis, testing whether attitudinal variables account for trends in sexual activity

	Sexually active (past 3 months)				
	Model 2: OR for Year partially adjusted (95% CI)	**Model 2 + Attitude to student smoking (95% CI)**	**Model 2 + Attitude to student drinking (95% CI)**	**Model 2 + Attitude to student cannabis use (95% CI)**	**Model 2 + all attitudinal factors combined**
2007	1	1	1	1	1
2012	0.44 (0.42, 0.47)	0.52*** (0.49, 0.56)	0.49* (0.47, 0.53)	0.43 (0.41, 0.46)	0.51** (0.48, 0.54)

All analyses are adjusted for age, sex, ethnicity and school decile
**p<.05 **p<.01 ***p<.001 statistically significant difference in OR from Model 2*

As previously noted, the associations between attitudes and behaviour are likely to be bi-directional. To test the extent to which *behaviours* explain *attitudes* (as opposed to vice versa) I conducted a trend analysis using attitudes to smoking, drinking and cannabis use as the

outcome variables and risk behaviours as the predictors (Table 44). The results, when viewed beside the previous trend analysis results, show that, for smoking and drinking, attitudes explain behaviour to a much greater extent than behaviours explain attitudes.

Table 44: 2001-2012 trend analysis testing whether risk behaviours account for trends in attitudinal variables

Year	Model 1: OR for Year partially adjusted (95% CI)	Model 1 + past month smoking (95% CI)	Model 1 + Past month binge drinking (95% CI)	Model 1 + Past month cannabis use (95% CI)	Model 1 + Substance use combined	Model 1 + sexually active
		Attitude to smoking				
2001	1	1	1	1	1	1
2007	0.41 (0.36, 0.47)	0.44 (0.38, 0.50)	0.41 (0.36, 0.47)	0.42 (0.36, 0.48)	0.44 (0.38, 0.51)	0.35 (0.30, 0.40)
2012	0.17 (0.15, 0.19)	0.20 (0.18, 0.23)	0.21 (0.18, 0.24)	0.18 (0.16, 0.21)	0.23* (0.20, 0.27)	0.16 (0.14, 0.18)
		Attitude to alcohol use				
2001	1	1	1	1	1	1
2007	0.50 (0.45, 0.56)	0.53 (0.47, 0.60)	0.50 (0.44, 0.56)	0.53 (0.47, 0.60)	0.53 (0.47, 0.60)	0.46 (0.41, 0.51)
2012	0.27 (0.24, 0.30)	0.31 (0.27, 0.35)	0.33 (0.29, 0.37)	0.29 (0.26, 0.33)	0.36** (0.32, 0.41)	0.27 (0.24, 0.30)
		Attitude to cannabis use				
2001	1	1	1	1	1	1
2007	0.59 (0.51, 0.69)	0.70 (0.60. 0.82)	0.70 (0.60, 0.82)	0.63 (0.54, 0.73)	0.76 (0.65, 0.91)	0.49 (0.42, 0.57)
2012	0.45 (0.39, 0.53)	0.64* (0.55, 0.76)	0.64* (0.54, 0.75)	0.69* (0.59, 0.81)	0.90*** (0.76, 1.08)	0.47 (0.40, 0.54)

All analyses are adjusted for age, sex, ethnicity and school decile
**p<.05 **p<.01 ***p<.001 statistically significant difference in OR from Model 1*

The attenuation of the trends for 'attitude to smoking' and 'attitude to alcohol use' were not statistically significant when past month substance use variables or sexual activity were added to the model individually. However, in combination, substance use variables did significantly attenuate the attitudinal trends, but for attitudes to tobacco and alcohol the proportion of the trend explained was modest. This suggests that changes in substance use behaviour made only a minor contribution to changes in tobacco and alcohol attitudes over time. Whereas (as shown in the previous analysis), changing attitudes towards tobacco and alcohol have made a major contribution to declines in all four risk behaviours.

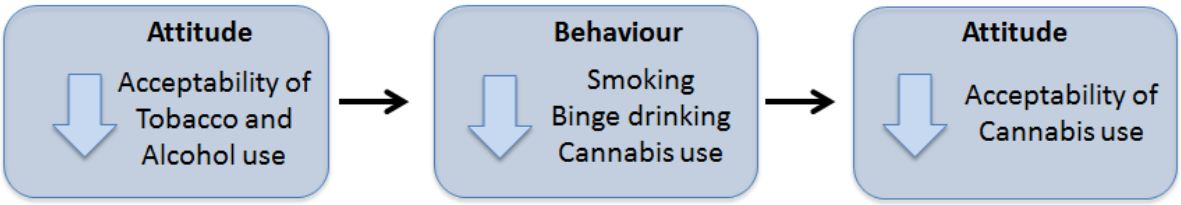
Interestingly, there was a different pattern for attitudes to cannabis. Past month smoking, past month binge drinking and past month cannabis use all partially explained the decline in acceptability of cannabis use over the study period. In combination, the substance use variables almost fully explained the change over time in attitude to cannabis (OR 0.90, 95% CI 0.76, 1.08). The results suggest that the observed decline in the acceptability of cannabis use in this age group is primarily a *consequence* (rather than a cause) of declining substance use.

The strong cross-relationships between attitudes to substance use and the four outcomes of interest highlight the fact that these behaviours (and attitudes towards them) are strongly correlated. As previously noted, these relationships are not necessarily causal. This modelling approach allows us to 'account for' trends over time in statistical terms, but appropriate interpretation of the findings relies on sound understanding of how risk behaviours are related to one another, cross-sectionally and longitudinally. These inter-relationships are further explored in the following chapter.

Discussion

In summary, the results show that there has been a marked decline in the acceptability of substance use among New Zealand adolescents over the course of the study period, indicating a change in injunctive norms. Declining acceptability of smoking and alcohol use in adolescents explained a substantial proportion of the decline in all four risk behaviours in the under 16 age group over the study period. These results cannot be explained by reverse causality. In contrast, attitude to cannabis use did *not* significantly contribute to risk behaviour trends. Although the acceptability of cannabis use declined over time, this appears to be a *consequence* of declining substance use, not a cause. The relationship between substance use attitudes and behaviours suggested by the findings of the current study is represented diagrammatically in Figure 60.

Figure 60: Hypothesised relationship between adolescent substance use attitudes and behaviours, New Zealand, 2001-2012



The relationships described in Figure 60 are consistent with established theory. Based on the theory of planned behaviour, we would expect decreasing acceptability of tobacco and alcohol to result in lower prevalence of smoking and binge drinking, as demonstrated in this study. Since cannabis is often consumed together with tobacco and/or alcohol (e.g. at parties), it follows that cannabis use will decline when binge drinking and smoking decline. And, based on Bem's theory of self-perception, it is understandable that a decline in adolescent cannabis use (alongside decreasing acceptability and use of alcohol and tobacco) might lead to decreasing acceptability of cannabis use in this age group. However the cross-relationships observed (e.g. between decreasing acceptability of smoking and declining sexual activity) seem unlikely to be causal and may be due to the clustering of these attitudes and behaviours.

New Zealand trends in adolescent attitudes to substance use are broadly similar to overseas trends, at least for tobacco and alcohol. Findings from England also show a decline since 2000 in the proportion of 11-15 year olds who felt smoking, drinking and cannabis use were OK in people their own age, with findings strongly age-related as they are in New Zealand (NHS Digital 2017). Monitoring the Future findings from the USA show that disapproval of smoking and binge drinking has increased among 8th graders (aged 13-14) since 2001, but the magnitude of attitude changes was small compared to those seen in New Zealand and England over the same period (Johnston et al. 2016).

In contrast to New Zealand, the acceptability of regular cannabis use in the USA was relatively stable among younger adolescents in the first years of the 21st century and increased markedly in the decade from 2007.[19] Over the same period there was a sharp drop in the perceived harmfulness of cannabis among adolescents in the USA. The acceptability of cannabis use also increased in English adolescents in the most recent period, between 2011 and 2016. However, against expectations, this liberalisation of attitudes to cannabis has *not* led to a marked rise in adolescent cannabis use in the USA or England. As discussed in Chapter 4, empirical investigation of this apparent paradox revealed that declines in alcohol and tobacco use over the period explained the lack of increase in cannabis use among US adolescents (Fleming et al. 2016, Miech et al. 2017).

[19] It is important to note that between-country and between-survey differences may be explained by differing question wording. For example, the Monitoring the Future survey asks 'Do you disapprove of people who…?', and does not include the age norm component included in the Youth 2000 (NZ) question. Findings might have been more similar if Monitoring the Future had asked 'Do you disapprove of people *your own age* who…?'

These findings suggest that reduced prevalence of risk behaviours may reflect changing attitudes of adolescents themselves and are not necessarily being imposed on young people by a heavily restrictive environment. But why have adolescents' attitudes about the acceptability of substance use among people their own age become more conservative? The possible role of parental modelling in changing adolescent attitudes and behaviours is investigated in Part 3 below.

Since this study and the following study use the same data set and analytical approach as that used in Chapter 6, the strengths and limitations of these studies are similar to those outlined in detail in the previous chapter. An additional strength is that the wording and answer categories of both the 'attitudes to substance use' questions and the 'parental substance use' questions in the Youth 2000 study have remained consistent across survey years, resulting in good comparability over time. Although missing data for the outcome variables was a potential problem, sensitivity analyses (Appendix B) showed that even under the most extreme assumptions about missing data, the pattern of findings in relation to attitudes was very similar to the main results presented above. Therefore I am confident that the conclusions of the study are robust.

Part 3: Parental substance use

Reviews have consistently highlighted the fact that parental modelling of substance use is a key predictor of adolescent uptake (White et al. 2000, Loxley et al. 2004, Ryan et al. 2010). Therefore it is important to examine whether parental substance use has changed over time, and whether this can partially explain changes in adolescent risk behaviour.

Analysis of ASH Year 10 data (Chapter 5) showed that changes in parental smoking did not contribute to the observed decline in adolescent smoking in Year 10 students (aged 14-15) in New Zealand between 2003 and 2015. The current study provides an opportunity to replicate that finding using data from a separate study, and to explore the possible role of parental alcohol use and cannabis use in the decline of adolescent risk behaviour.

Research questions

- Is there an association between parental substance use in the home setting, and risk behaviour (smoking, drinking, cannabis use and sexual activity) in adolescents?

- Has prevalence of parental substance use in the home changed over the course of the study period, as reported by adolescents?
- To what extent do changes in parental substance use account for declining trends in adolescent risk behaviour?

Methods

This study takes a similar approach to that used in the trend analyses outlined in Chapter 6 and in Part 2 above.

Data and participants

This study uses Youth 2000 data, with the analysis restricted to responses from younger adolescents (aged less than 16 years). The survey and participant characteristics are described in Chapter 6.

Variables

The outcome variables are the same as those used in other Youth 2000 trend analyses: past month smoking, past month cannabis use, past month binge drinking, and being sexually active. Details are provided in Chapter 6.

Parental substance use is based on the question: 'Which of the following do your parents or someone who acts as your parents use in your home?

Drug3_1: Cigarettes, tobacco

Drug3_2: Alcohol (e.g. beer, wine, spirits, etc.)

Drug3_3: Marijuana (e.g. cannabis, weed, pot, hash, grass, etc.)

A dichotomous (Yes/No) variable was created for each substance.

Demographic variables were the same as those in other Youth 2000 trend analyses: age, sex, ethnicity and school decile.

Analysis

First, to determine whether parental substance use was associated with the outcomes of interest, bivariate associations between each parental substance use variable and each outcome were calculated using logistic regression. All models were adjusted for age, sex,

school decile and ethnicity, and results were expressed as odds ratios (OR) and 95% confidence intervals (CI).

Then trends in parental substance use were investigated by using descriptive statistics to calculate the proportion of students that reported parental use of tobacco, alcohol and/or cannabis in the home for each survey year. Proportions were adjusted for clustering and weighting of the complex sample design.

Finally trend analyses were conducted using logistic regression. To test the extent to which parental substance use accounted for the change over time in the risk behaviours of interest, I modelled each outcome (past month smoking, past month cannabis use, past month binge drinking and sexually active in the past 3 months) as a function of survey year. This model was adjusted for demographic factors (age, sex, ethnicity and school decile), and included school ID as a random effect to account for clustering at the school level. I then added the parental substance use variables to this base model, first individually then collectively. Significant attenuation of the OR for year, which was tested using Z tests to compare log odds, would indicate that parental substance use (partially) accounted for the trend over time.

All analyses were adjusted for the weighting and clustering in the complex sampling design, and were conducted using PROC SURVEYFREQ and PROC GLIMMIX in Version 9.4 of the SAS system for Windows.

Results

Associations between parental substance use and adolescent risk behaviour

As shown in Table 45, there were moderate to strong associations between parental substance use in the home and adolescent risk behaviour, after adjusting for students' age, sex, ethnicity and school decile. There was evidence of a substance-specific effect (i.e. parental smoking had the strongest association with adolescent smoking, parental alcohol use had the strongest association with adolescent binge drinking, and parental cannabis use had the strongest association with adolescent cannabis use).

As well as substance-specific effects there were also consistent cross-behaviour effects, for example adolescents whose parents used cannabis in the home were not only six times more likely to smoke cannabis than those whose parents were not cannabis users, but also three to four times more likely to smoke tobacco, binge drink, and be sexually active. These cross-

relationships may be due to unmeasured confounders (e.g. parental mental health problems, neighbourhood factors) associated with both parental substance use and adolescent risk behaviours, and/or they may reflect strong correlations between the parental behaviours of interest.

Table 45: Associations between parental substance use and adolescent risk behaviours, 2001-2012 (pooled)

	Past month smoking OR (95% CI)	Past month binge drinking OR (95% CI)	Past month cannabis use OR (95% CI)	Sexually active OR (95% CI)
Parents smoke in the home	2.85 (2.71, 3.01)	2.04 (1.96, 2.12)	2.16 (2.05, 2.27)	2.13 (2.03, 2.22)
Parents drink alcohol in the home	1.62 (1.53, 1.72)	2.40 (2.30, 2.50)	1.60 (1.51, 1.69)	1.35 (1.28, 1.41)
Parents smoke cannabis in the home	3.26 (3.02, 3.53)	3.86 (3.61, 4.13)	6.32 (5.88, 6.80)	3.95 (3.69, 4.23)

All associations are adjusted for age, sex, ethnicity and school decile.

To adjust for potential correlations between parental tobacco, alcohol and cannabis use, I repeated the analysis above, this time adjusting for the other parental behaviours as well as demographic factors. The results are presented in Table 46. All of the relationships remained statistically significant, but the effect sizes decreased.

Table 46: Adjusted associations between parental substance use and adolescent risk behaviours, 2001-2012 (pooled)

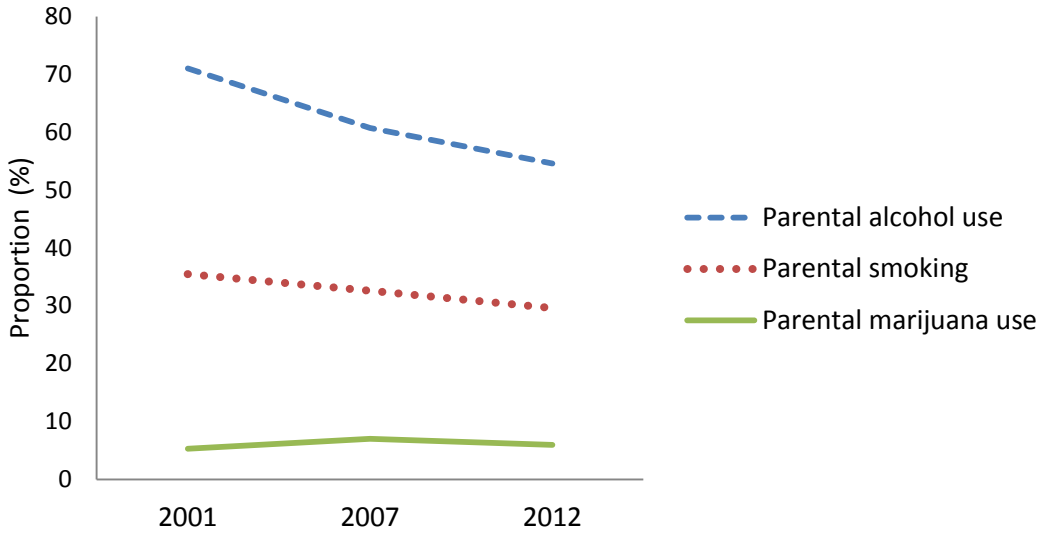
	Past month smoking OR (95% CI)	Past month binge drinking OR (95% CI)	Past month cannabis use OR (95% CI)	Sexually active OR (95% CI)
Parents smoke tobacco in the home	2.49 (2.36, 2.63)	1.65 (1.51, 1.80)	1.68 (1.59, 1.78)	1.82 (1.73, 1.90)
Parents drink alcohol in the home	1.31 (1.23, 1.39)	2.03 (1.86, 2.22)	1.29 (1.22, 1.37)	1.12 (1.06, 1.16)
Parents smoke cannabis in the home	2.38 (2.20, 2.58)	3.30 (2.91, 3.74)	5.15 (4.78, 5.55)	3.19 (2.98, 3.42)

Associations are adjusted for other parental substance use variables and age, sex, ethnicity and school decile.

Trends in parental substance use

Trends in parental substance use in the home setting, as reported by students, are presented in Figure 61. As shown, the proportion of students reporting their parents drank alcohol in the home fell significantly from 71% in 2001 to 55% in 2012.

Figure 61: Proportion (%) reporting parental alcohol, tobacco and cannabis use, 2001-2012



Parental smoking in the home declined to a lesser extent, from 36% to 30%. Few students (5-7%) reported their parents smoked cannabis in the home, with no significant change over the study period.

Table 47 shows the results of the trend analysis, which suggests that parental substance use did not make a statistically significant contribution to the decline in adolescent risk behaviours over the study period.

Table 47: 2001-2012 trend analysis testing whether parental substance use accounts for trends in risk behaviours

Year	Model 1: OR for Year partially adjusted (95% CI)	Model 1 + Parental tobacco use	Model 1 + Parental alcohol use	Model 1 + Parental cannabis use	Model 1 + Parental substance use (combined)
	Past month smoking				
2001	1	1	1	1	1
2007	0.48 (0.41, 0.57)	0.48 (0.40, 0.56)	0.50 (0.42, 0.59)	0.46 (0.39, 0.54)	0.46 (0.39, 0.54)
2012	0.20 (0.17, 0.23)	0.21 (0.17, 0.25)	0.21 (0.17, 0.25)	0.19 (0.16, 0.22)	0.20 (0.17, 0.24)
	Past month cannabis use				
2001	1	1	1	1	1
2007	0.58 (0.48, 0.69)	0.57 (0.48, 0.67)	0.59 (0.49, 0.70)	0.51 (0.43, 0.60)	0.52 (0.44, 0.61)
2012	0.32 (0.26, 0.38)	0.33 (0.28, 0.39)	0.34 (0.28, 0.40)	0.29 (0.24, 0.34)	0.30 (0.26, 0.36)
	Past month binge drinking				
2001	1	1	1	1	1
2007	0.77 (0.68, 0.88)	0.77 (0.67, 0.87)	0.82 (0.72, 0.93)	0.74 (0.65, 0.84)	0.78 (0.69, 0.89)
2012	0.33 (0.29, 0.37)	0.34 (0.29, 0.38)	0.36 (0.31, 0.41)	0.31 (0.27, 0.36)	0.34 (0.30, 0.39)
	Sexually active (past 3 months)				
2001	1	1	1	1	1
2007	1.56 (1.37, 1.78)	1.62 (1.44, 1.85)	1.64 (1.44, 1.88)	1.55 (1.36, 1.77)	1.58 (1.39, 1.79)
2012	0.68 (0.60, 0.78)	0.73 (0.64, 0.83)	0.72 (0.63, 0.83)	0.67 (0.59, 0.77)	0.70 (0.62, 0.80)

Parental smoking, drinking and cannabis use did not (individually or collectively) significantly attenuate the OR for survey year for any of the four adolescent risk behaviours over the study period. There was a possible trend towards parental drinking contributing to adolescent binge drinking trends, but the magnitude of the effect was small and did not reach statistical significance.

Discussion

The finding that parental substance use had behaviour-specific associations with adolescent substance use is consistent with the theory that parental modelling influences adolescent behaviour. However it is also consistent with evidence that parents' own behaviour is associated with rule setting and expectations about their

children's behaviour (e.g. parents who smoke at home are more likely than non-smokers to be permissive about smoking), which in turn influences adolescents' behaviour (Harakeh et al. 2005, Waa et al. 2011). Parental use of specific substances is also likely to increase adolescents' access to that substance, since young people may get tobacco, alcohol or cannabis from their parents, with or without permission (White 2013, Kelly et al. 2016). Therefore parental modelling is one of several mechanisms whereby parental substance could influence substance use in adolescents.

Although prevalence of parental alcohol use and, to a lesser extent, parental tobacco use declined over the study period, these changes did not contribute significantly to the decline in adolescent risk behaviour between 2001 and 2012 in New Zealand adolescents.

As far as I am aware, this is the first study (other than that described in Chapter 5) to explore the possible effects of changing parental substance use on adolescent trends. The findings are consistent with the study reported in Chapter 5, which found that declines in parental smoking did not contribute to declines in adolescent smoking.

The substantial decline in parental alcohol use at home (as reported by students) was unexpected, given that the proportion of non-drinkers in the adult population has increased only modestly over the study period (Ministry of Health 2017). This finding could indicate that parental attitudes to adolescent drinking have become less permissive in New Zealand, as they have in many other high-income countries, leading parents to change their own drinking habits in line with expectations of non-drinking in their offspring. Or alternatively it could indicate increasing financial pressures on families during a period of sharply rising living costs. It is certainly an interesting finding, and one that is worthy of further research.

Conclusions

The findings of this chapter indicate that age of initiation for smoking, drinking, cannabis use and sexual intercourse increased in New Zealand adolescents between 2007 and 2012. I also found that the acceptability of substance use declined substantially among adolescents over the 2001-2012 study period. The findings demonstrate empirically that changes in attitudes to tobacco and alcohol use made a substantial contribution to recent declines in risk behaviours in 13-15 year olds. In contrast, declines in the prevalence of parental alcohol and tobacco use

in the home environment did not contribute significantly to declines in adolescent risk behaviours over the study period.

Returning to the question of whether declining risk behaviour is a 'unitary trend' or a collection of separate trends: based on the findings of this chapter, it seems likely that tobacco-specific and alcohol-specific factors (i.e. attitudes to these behaviours) have been primary drivers of declines in adolescent smoking and drinking, with possible knock-on effects to cannabis use and sexual activity. This hypothesis is tested in the following chapter.

CHAPTER 8. YOUTH 2000: INTER-RELATIONSHIPS AND INDEPENDENT CONTRIBUTORS

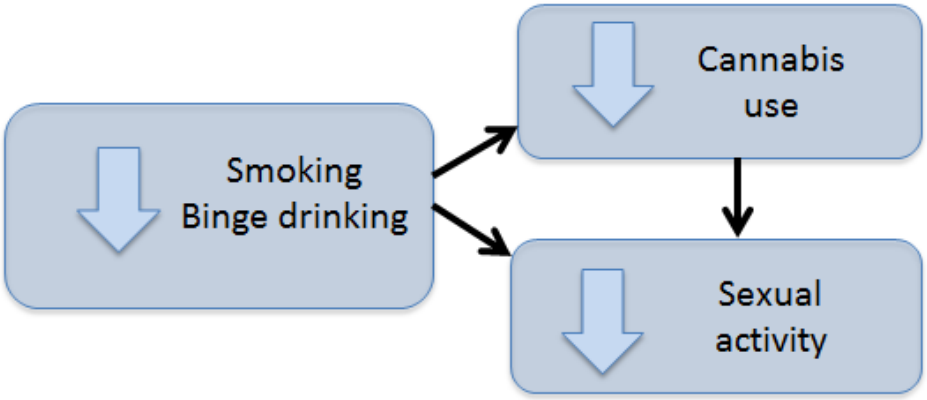
Introduction

The preceding two chapters explored the possible contribution of a wide range of factors to the decline in adolescent risk behaviours in New Zealand adolescents in the early part of the 21st century, using Youth 2000 data. So far, these possible contributors have largely been examined one at a time, and I have also treated the outcomes of interest (i.e. adolescent smoking, cannabis use, binge drinking and sexual activity) separately. In this chapter, Part 1 examines the inter-relationships between risk behaviour trends, and Part 2 investigates the independent contribution of each predictor variable in mutually adjusted models. These fully adjusted models also determine the extent to which the predictor variables, in combination, explain trends in smoking, cannabis use, binge drinking and sexual activity in the New Zealand context.

Part 1: Contribution of other risk behaviours

As discussed in Chapter 2, it is well established that risk behaviours are highly correlated at the individual level, which helps to explain why population trends for various risk behaviours might move in parallel. Longitudinal research has shown that, at the individual level, engaging in one risk behaviour (in particular smoking or drinking) increases the likelihood of engaging in other risk behaviours subsequently (Jackson et al. 2002, Agrawal et al. 2006, Van Ryzin et al. 2012). This begs the question: do declines in one risk behaviour help to explain declines in the others at the population level? More specifically, do declines in adolescent use of tobacco and alcohol have knock on effects to cannabis use and sexual activity, as suggested by the results of the previous chapter? This hypothesis is presented diagrammatically in Figure 62. The aim of Part 1 is to explore these questions.

Figure 62: Hypothesised relationship between adolescent smoking, binge drinking, cannabis and sexual activity trends.



Research questions

- What are the associations between the risk behaviours of interest in the New Zealand secondary school population aged under 16?
- To what extent are trends in each risk behaviour explained by declines in other risk behaviours in this population?

Methods

The approach is the same as that used in previous trend analyses, but in this case the predictor variables are the other risk behaviours.

Data and participants

This study also uses Youth 2000 data, and is restricted to those aged under 16 years. Details of the survey methods and participant characteristics are provided in Chapter 6.

Outcome variables

The outcome variables are the same as for the other Youth 2000 trend analyses: past month smoking, past month cannabis use, past month binge drinking, and being sexually active in the past 3 months. Details are available in Chapter 6.

Predictor variables

For each outcome variable, the predictor variables are the other outcomes (i.e. risk behaviours). For example, for tobacco decline, the predictor variables are past month binge drinking, past month cannabis use, and sexual activity.

Demographic variables

Demographic variables were : age, sex, ethnicity, and school decile. Details are provided in Chapter 6.

Analysis

First, to investigate the relationships between the risk behaviours of interest, bivariate associations were calculated using logistic regression, adjusting for age, sex, school decile and ethnicity. Then the *independent* associations were calculated, adjusting for the other risk behaviours as well as demographic factors to address confounding. Results are expressed as odds ratios (OR) and 95% confidence intervals (CI).

Next, as in previous trend analyses, I modelled prevalence of each risk behaviour as a function of survey year, adjusting for demographic factors (age, sex, ethnicity and school decile), and including school ID as a random effect to account for clustering at the school level. This was Model 1, the base model. I then added the remaining risk behaviour variables to Model 1, individually, and then (for substance use variables) collectively. Significant attenuation of the OR for year, which was tested using Z tests to compare log odds, would indicate that the added variable(s) helped to account for the trend over time.

All analyses were adjusted for the weighting and clustering in the complex sampling design, and were conducted using PROC SURVEYFREQ and PROC GLIMMIX in Version 9.4 of the SAS system for Windows.

Results

Associations between risk behaviours

Table 48 shows very strong bivariate associations between the different risk behaviours, after adjustment for age, sex, ethnicity and school decile. For example, the first column shows the odds of past month tobacco smoking are greatly elevated among past month cannabis users (OR 13.3), past month binge drinkers (OR 10.7), and sexually active adolescents (OR 7.2) compared with those who did not engage in each of these risk behaviours.

Table 48: Partially adjusted associations (ORs) between risk behaviours, 2001-2012 pooled

	Smoking	Cannabis	Binge drinking
Smoking			
Cannabis	13.3 (12.5, 14.2)		
Binge drinking	10.7 (10.0, 11.4)	13.2 (12.4, 14.0)	
Sexually active	7.2 (6.8, 7.6)	8.3 (7.9, 8.8)	7.9 (7.5, 8.3)

Adjusted for age, sex, ethnicity and school decile

Table 49 shows the *independent* relationships, adjusting for the other risk behaviours as well as demographic factors. After full adjustment, all the ORs were considerably attenuated, indicating that confounding or mediation by other risk behaviours was occurring in the partially adjusted models in Table 48. For example, the results suggest that the relationship between tobacco use and sexual activity operates partially 'via' binge drinking and/or cannabis use. However even after full adjustment, the relationships between risk behaviours remain very strong. Binge drinking and cannabis use have the strongest independent association (OR 6.8), followed by tobacco and cannabis use (OR 5.2), tobacco and binge drinking (OR 5.1), and binge drinking and sexual activity (OR 4.5).

Table 49: Mutually adjusted associations (ORs) between risk behaviours, 2001-2012 (pooled)

	Smoking	Cannabis	Binge drinking
Smoking			
Cannabis	5.2 (4.8, 5.6)		
Binge drinking	5.1 (4.7, 5.5)	6.8 (6.3, 7.3)	
Sexually active	2.7 (2.5, 2.9)	3.2 (3.0, 3.4)	4.5 (4.3, 4.9)

Adjusted for demographic factors (age, sex, ethnicity, school decile) and other risk behaviours

As discussed in Chapter 2 the extent to which these correlations represent 'common liability' or causal relationships between risk behaviours is still under debate.

To what extent are trends in one risk behaviour explained by changes in the others?

Table 50 below shows the trend for each outcome variable (expressed as an OR for year, with 2001 as the reference) and then tests the extent to which the remaining risk behaviours (individually, and substance use in combination) account for the trend, in statistical terms.

Table 50: Trend analysis showing extent to which trends in one risk behaviour are accounted for by other risk behaviours, 2001-2012

Year	Model 1: OR for Year partially adjusted (95% CI)	Model 1 + Past month smoking (95% CI)	Model 1 + Past month binge drinking (95% CI)	Model 1 + Past month cannabis use (95% CI)	Model 1 + Sexually active (95% CI)	Model 1+ Use of other substances combined (95% CI)
	Past month smoking					
2001	1	-	1	1	1	1
2007	0.48 (0.41, 0.57)	-	0.50 (0.42, 0.60)	0.53 (0.44, 0.64)	0.38 (0.32, 0.45)	0.53 (0.44, 0.63)
2012	0.20 (0.17, 0.23)	-	0.29* (0.24, 0.35)	0.25 (0.21, 0.31)	0.19 (0.16, 0.22)	0.32* (0.26, 0.38)
	Past month cannabis use					
2001	1	1	1	-	1	1
2007	0.58 (0.48, 0.69)	0.73 (0.60, 0.88)	0.63 (0.52, 0.76)	-	0.46 (0.38, 0.56)	0.76 (0.62, 0.93)
2012	0.32 (0.26, 0.38)	0.51* (0.42, 0.61)	0.52* (0.43, 0.63)	-	0.32 (0.26, 0.38)	0.70* (0.58, 0.86)
	Past month binge drinking					
2001	1	1	-	1	1	1
2007	0.77 (0.68, 0.88)	0.91 (0.80, 1.04)	-	0.86 (0.75, 0.98)	0.67 (0.58, 0.77)	0.96 (0.84, 1.10)
2012	0.33 (0.29, 0.37)	0.42* (0.37, 0.48)	-	0.38 (0.34, 0.44)	0.31 (0.27, 0.36)	0.45* (0.39, 0.52)
	Sexually active (past 3 months)					
2001	1	1	1	1	-	1
2007	1.56 (1.37, 1.78)	2.09* (1.82, 2.39)	1.89 (1.64, 2.17)	1.94 (1.69, 2.22)	-	2.30* (1.99, 2.65)
2012	0.68 (0.60, 0.78)	1.03* (0.90, 1.19)	1.12* (0.97, 1.29)	0.98* (0.85, 1.13)	-	1.50* (1.29, 1.73)

All models are adjusted for demographic factors: sex, age, ethnicity and school decile

**p<.05*

A supplementary analysis of the 2007-2012 period was also conducted (Table 51), since this provides a more valid analysis of the decline in sexual behaviour and also enables us to look at the two halves of the study period separately.

Table 51: Trend analysis showing the extent to which trends in one risk behaviour are accounted for by other risk behaviours, 2007-2012

Year	Model 1: OR for Year Partially adjusted (95% CI)	Model 1 + Past month smoking (95% CI)	Model 1 + Past month binge drinking (95% CI)	Model 1 + Past month cannabis use (95% CI)	Model 1 + sexually active	Model 1+ Other risk behaviours combined
	Past month smoking					
2007	1	1	1	1	1	1
2012	0.41 (0.37, 0.44)	-	0.60*** (0.54, 0.66)	0.48* (0.44, 0.53)	0.51*** (0.46, 0.56)	0.66*** (0.59, 0.74)
	Past month cannabis use					
2007	1	1	1	-	1	1
2012	0.56 (0.52, 0.61)	0.71*** (0.65, 0.77)	0.86*** (0.78, 0.93)		0.70*** (0.65, 0.77)	1.04*** (0.94, 1.15)
	Past month binge drinking					
2007	1	1	-	1	1	1
2012	0.42 (0.40, 0.45)	0.46* (0.44, 0.49)		0.44 (0.42, 0.47)	0.47* (0.44, 0.49)	0.48** (0.45, 0.52)
	Sexually active (past 3 months)					
2007	1	1	1	1	-	1
2012	0.44 (0.42, 0.47)	0.50* (0.47, 0.54)	0.61*** (0.57, 0.65)	0.51** (0.48, 0.55)		0.67*** (0.63, 0.72)

All models are adjusted for demographic factors: sex, age, ethnicity and school decile

**p<.05 **p<.01 ***p<.001*

Past month smoking

The results suggest that declines in binge drinking made a statistically significant contribution to declines in adolescent smoking over the study period, particularly in the latter period, 2007-2012. Declines in cannabis use also contributed, but this was only statistically significant in the 2007-2012 period, not in the study period as a whole. Declining sexual activity also partially explained the smoking trend in the latter (2007-12) period. In summary, binge drinking, cannabis and sexual activity explained very little of the decline in smoking in the first half of the study period (2001-2007), but explained a substantial proportion in the latter half (2007-2012), with the decline in binge drinking the biggest contributor. However, even in 2007-2012, much of the decline in adolescent smoking remains unexplained by this model.

Past month cannabis use

The decline in cannabis use was largely explained by declines in smoking and binge drinking, with declining sexual activity also contributing in the 2007-2012 period. Smoking made a greater contribution than binge drinking in the 2001-2007 period, whereas binge drinking was more important in the 2007-2012 period, such that each made a similar contribution over the study period as a whole. In combination smoking and binge drinking explained a large proportion of the decline in cannabis use over the study period as a whole, and in combination with sexual activity they fully explained the decline in the 2007-2012 period.

Past month binge drinking

Adjustment for smoking and cannabis use, in combination, fully explained the decline in binge drinking in the 2001-2007 period, with the decline in smoking making the biggest contribution. However, in the 2007-2012 period, cannabis use did not contribute significantly to the decline in binge drinking, and smoking and sexual activity made only small (but statistically significant) contributions. In summary, declining binge drinking in the 2001-2007 period appears to be a knock on effect of declining smoking and (to a lesser extent) declining cannabis use. However, in the 2007-2012 period a large majority of the decline in binge drinking remains unexplained with the other risk behaviours only explaining a small proportion of the decline.

Sexual activity

The findings suggest that the decline in the proportion sexually active between 2007 and 2012 was substantially, but not fully, explained by declining substance use. All three substances significantly attenuated the trend individually, with past month binge drinking having the largest effect. The combined effect was greater than any one substance individually, but still left some of the 2007-2012 decline in sexual activity unexplained.

Discussion

The findings support the hypothesis that declines in adolescent cannabis use and sexual activity were substantially explained by declines in the other risk behaviours, particularly smoking and binge drinking. The decline in binge drinking contributed significantly to declines in all three other risk behaviours, with most of the effect occurring in the latter 2007-2012 period. Smoking decline also contributed substantially to declines in all of the other three risk behaviours, with the effect more pronounced in the first part of the study period when the decline in tobacco use was at its steepest. In the latter period, all the risk behaviours significantly explained declines in all the other risk behaviours, with one exception: past month cannabis use did not significantly explain past month binge drinking.

The findings in relation to cannabis use are consistent with US research discussed in Chapter 4 which found that declines in tobacco and alcohol use explained the stability in adolescent cannabis trends despite liberalisation of attitudes to cannabis (Fleming et al. 2016, Miech et al. 2017). As demonstrated in a further study set in Norway: young people have become more willing to try cannabis, but opportunities to do so are occurring less frequently (Burdzovic & Bretteville-Jensen 2017). It is likely that opportunities for cannabis use often arise in the context of drinking and/or tobacco smoking with peers, so it follows that declines in drinking and smoking result in fewer opportunities for cannabis use. It is also possible that the disinhibiting effects of alcohol may make young people more willing to try cannabis if it is offered when they are drinking. If so, it follows that a decrease in binge drinking may also be contributing to declining cannabis use via a decrease in intoxicated decision making. Furthermore there is evidence of a complementary relationship between tobacco and cannabis (Agrawal et al. 2012). That is, because they are often consumed together, a decrease in demand for one has been shown to result in a decrease in demand for the other, which helps to explain how declining tobacco use may have contributed causally to declines in cannabis use among adolescents (Agrawal et al. 2012).

Some of the same causal mechanisms plausibly explain how the decline in substance use (in particular, binge drinking) could account for the decline in sexual activity: fewer opportunities and less disinhibition. I am not aware of any studies that have tested this hypothesis empirically, but associations between alcohol use and sexual behaviour are well documented (George & Stoner 2000, Aicken et al. 2011) and there is evidence that population declines in adolescent drinking are associated with declines in unprotected sex, at least among young men in certain US states (Chesson et al. 2000, Carpenter 2005).

Since tobacco does not have the intoxicating effects of alcohol or cannabis, it seems likely that much of the apparent effect of smoking on sexual activity trends may be due to smoking being a marker for drinking and cannabis use, factors which may be causally related to sexual activity. However longitudinal research has shown that smoking in early adolescence is predictive of association with ‘deviant peers’ in subsequent years, suggesting that smoking may increase likelihood of other risk behaviours via peer selection (Van Ryzin et al. 2012). In other words, smoking may draw young people into a peer group that then influences them to engage in other risk behaviours.

The findings in relation to tobacco and alcohol are consistent with economic research showing that among adolescents these are ‘complementary goods’ in economic terms (Dee 1999). A

decrease in demand for one has been demonstrated to result in a decrease in demand for the other, presumably because they are often consumed together (Dee 1999). Thus the steep decline in tobacco use in the first half of the study period helps to explain the decline in binge drinking over that period, and the decline in binge drinking in the second half of the study period partially explains the decline in smoking.

I have argued that results of the current study are consistent with causal relationships between risk behaviours and this is supported by international research, economic theory, and plausible causal mechanisms. However, an alternative interpretation is that the apparent 'contribution' of other risk behaviours is not causal but reflects common liability (i.e. factor(s) that underlie all four risk behaviours) and/or the clustering of risk behaviours such that each is a marker for the others. For example, the finding that declining sexual activity contributed to declining cannabis use in the latter half of the study period seems unlikely to reflect a causal relationship, due to lack of plausible causal mechanisms. The finding is more likely to be explained by common liability, or by the fact that sexual activity is a marker for drinking and smoking which have plausibly had a causal influence on cannabis use.

For both tobacco and binge drinking the majority of the decline over the study period as a whole is not accounted for by changes in the other risk behaviours. This contrasts sharply with cannabis trends which are completely accounted for by declines in other risk behaviours in the second half of the study period, and sexual activity which is substantially explained by declines in substance use. This lack of symmetry across the study period as a whole is suggestive of causality from smoking and binge drinking to cannabis use and sexual activity, rather than common liability underlying all four trends which would produce a more symmetrical pattern of results across the risk behaviour outcomes (as seen in Chapter 6).

However, it is interesting to note that although trends for the four outcomes differed markedly in the first half of the study period (e.g. smoking declined substantially, binge drinking declined modestly, and sexual activity increased), in the second half declines were more symmetrical across behaviours. As previously noted, in the 2007-2012 period all the risk behaviours significantly explained declines in all the other risk behaviours (with one exception). Thus the results in the second half of the study period are more consistent with the common liability hypothesis. For example a decline in 'going out' or 'partying' with friends could help to explain contemporaneous and inter-related declines in adolescent smoking, drinking, drug use and sexual activity since 2007. This interpretation is supported by the recent study by de Looze et al (2019) discussed in Chapter 4 which found that, at the national

level, decreases in face to face contact between peers in the evening were associated with declines in substance use in Europe and North America (de Looze et al. 2019). However it seems to be at odds with my findings in Chapter 6 which showed that a decline in time spent hanging out with friends was *not* a significant contributor to adolescent trends. But as noted in that chapter, it is possible that the Youth 2000 question wording did not pick up important changes in where and when young people spend time together. They may indeed be going out at night with friends less frequently, but this is yet to be established in the New Zealand context. But even if a decline in going out is established, the question of the direction of causality remains. Is less going out leading to fewer opportunities for risk behaviour, or is less inclination to engage in risk behaviour leading to less going out? These questions cannot be answered using repeat cross-sectional data and remain an area for further research.

Disentangling the effects of complementarity, causal relationships, common liability and confounding between risk behaviours is not straightforward. I have argued that declines in binge drinking and smoking provide a causal explanation for the decline in cannabis use, and that declines in substance use have contributed causally to the decline in sexual activity. Furthermore I argue that in the latter half of the study period a decline in 'going out' may help to explain declines in all four risk behaviours. These interpretations are consistent with the observed results, and are also supported by theory and evidence from the literature. However, they are not definitive, and remain to be tested through further research.

Part 2: The full model

My empirical analysis of Youth 2000 data indicates that out of all the predictors examined, those that stand out as major contributors to risk behaviour trends were attitudinal and behavioural factors. Specifically, they were:

- age of initiation for smoking, drinking, cannabis use and sex
- proportion of adolescents who think it is OK for people their own age to smoke regularly
- proportion of adolescents who think it is OK for people their own age to drink alcohol regularly
- proportion who smoked tobacco in the past month
- proportion who engaged in binge drinking in the past month
- proportion who used cannabis in the past month.

In addition, other factors, in home, school and leisure settings (e.g. parental alcohol use, parental monitoring, perceived quality of family relationships, intention to complete school, time spent hanging out with friends) may have made a small contribution in combination. Part 2 puts all of the Youth 2000 predictors together in a full model to address the following questions.

Research questions

- To what extent does the full model – including all the available predictor variables – explain trends over time in each risk behaviour?
- Which of the predictors are the strongest independent contributors, after adjusting for demographic factors and all the other predictors?

It is important to note that, although increasing age of initiation is an important contributor to the observed decline in risk behaviour in 13-15 year olds, as demonstrated in Chapter 7, unfortunately, it is not possible, methodologically, to include age of initiation alongside other predictors to investigate their relative importance.

Methods

The results of earlier Youth 2000 analyses suggest that the drivers of decline may be different in the two halves of the study period. Therefore I have modelled the 2001-2007 and 2007-2012 periods separately. Note that 'time spent hanging out with friends' was not available for 2001, so is only included in the 2007-2012 models.

For each risk behaviour – smoking, binge drinking, cannabis use and sexual activity –and for each half of the study period, I calculated the OR for year i.e. the likelihood of an individual engaging in that behaviour compared to the reference year, unadjusted (Model 0) and adjusted for demographic factors (Model 1). I then constructed a full model including all the predictor variables (Model 2). This enabled investigation of the extent to which the full model accounted for declines in each risk behaviour.

In order to determine the independent contribution of each predictor, I then took *out* each predictor variable from Model 2 in turn, to see how it affected the OR in the fully adjusted model. With this approach, an attenuation *away from* 1 would indicate that the predictor was an independent contributor (i.e. the smaller the OR, compared with Model 2, the bigger the independent effect).

Results

Smoking

As shown in Table 52, the odds of an adolescent smoking in 2007 compared to 2001 were OR 0.46 (0.38, 0.56) after adjusting for demographic factors (Model 1). After including all available predictors (Model 2), the OR was 0.60 (0.47, 0.75), indicating that in the first half of the study period, the included predictors in combination made only a small contribution to the decline in adolescent smoking.

Table 52: Smoking trend analysis, 2001-2007, full model

Model 0	OR 2007 (ref 2001) – unadjusted	0.41
Model 1	OR 2007 (ref 2001) – adjusted for demographics	0.46
Model 2	2007 (ref 2001) – fully adjusted	0.60
OR for 2007, full model (Model 2) EXCEPT the named variable(s)		
Home factors	Parental monitoring	0.60
	Fun with family	0.60
	Family relationship	0.58
	Maternal closeness	0.60
	Paternal closeness	0.60
	Maternal warmth	0.59
	Paternal warmth	0.60
School factors	Students are treated fairly	0.59
	Sense of belonging at school	0.58
	School expects me to do well	0.60
	Intention to complete school	0.60
	Plans after leaving school	0.61
Leisure factors	Part time job	0.60
Attitudes to substance use	**OK to smoke regularly**	**0.49**
	OK to drink alcohol regularly	0.61
	OK to use cannabis regularly	0.60
Parental substance use	Parental smoking	0.60
	Parental alcohol use	0.60
	Parental cannabis	0.60
Other risk behaviours	Past month cannabis use	0.58
	Past month binge drinking	0.63
	Sexually active	0.68
Factors in combination	Home factors + parental substance use	0.61
	School factors	0.58
	Attitudes to substance use	**0.46**
	Past month cannabis & binge drinking combined	0.61
	All other risk behaviours combined	0.73

However it is important to acknowledge that in the full model some of the included factors – sexual activity, binge drinking, plans after leaving school, and attitude to drinking – put *upward* pressure on smoking trends (indicated by the OR moving closer to one when each was removed from the model), thus 'counteracting' the effects of other variables in the model. Supplementary analysis showed that exclusion of these four variables results in a fully adjusted OR of 0.75 (0.60, 0.94).

In Tables 51-58, variables (or groups of variables) are highlighted if removing them from the model resulted in an attenuation of the OR of 10% or more compared with Model 2.

The predictor that made the biggest independent contribution to the trend, by a large margin, was the attitude of adolescents to smoking (i.e. 'OK to smoke regularly'). Family relationship, sense of belonging at school and past month cannabis use also showed minor independent contributions. Interestingly, in the fully adjusted model past month binge drinking is not an independent contributor to smoking trends in the first half of the study period, and in fact appears to be putting *upward* pressure on the trend (i.e. the OR for year increased rather than decreased when this factor was removed from the full model). This was also the case for sexual activity, however this was expected because the proportion who were sexually active increased between 2001 and 2007. Cannabis use made a small independent contribution to declining tobacco use, but in combination the other risk behaviours made a *negative* contribution. This indicates that adolescent smoking declined *in spite of* rather than because of the influence of other risk behaviours in the 2001-2007 period.

The second half of the study period presents a very different picture (Table 53). The likelihood of smoking in 2012 was OR 0.41 (0.38, 0.45) compared with 2007, after adjusting for demographic factors (Model 1). When all of the predictors were included (Model 2) the OR was greatly attenuated (OR 0.89, 95% CI 0.79, 1.01) indicating that the majority of the decline in smoking in the second half of the study period was accounted for by the included predictors.

In the latter half of the study period, attitude to smoking was still the biggest single independent contributor, followed by binge drinking. Past month cannabis use, part time work and time hanging out with friends were also minor independent contributors, along with intention to complete school, and sexual activity. In combination, leisure factors made a notable independent contribution, but it was small compared to the contribution of attitudes

to substance use, and other risk behaviours (past month cannabis use, past month binge drinking, and sexual activity).

Table 53: Smoking trend analysis, 2007-2012, full model

Model 0	OR 2012 (ref 2007) –unadjusted	0.47
Model 1	OR 2012 (ref 2007) – adjusted for demographics	0.41
Model 2	2012 (ref 2007) – fully adjusted	0.89
OR for 2012, full model (Model 2) EXCEPT the named variable(s)		
Home factors	Parental monitoring	0.91
	Fun with family	0.89
	Family relationship	0.89
	Maternal closeness	0.90
	Paternal closeness	0.90
	Maternal warmth	0.89
	Paternal warmth	0.90
School factors	Students are treated fairly	0.90
	Sense of belonging at school	0.90
	School expects me to do well	0.90
	Intention to complete school	0.85
	Plans after leaving school	0.90
Leisure factors	Part time job	0.84
	Time hanging out with friends	0.84
Attitudes to substance use	**OK to smoke regularly**	**0.69**
	OK to drinking regularly	0.90
	OK to use cannabis regularly	0.89
Parental substance use	Parental smoking	0.89
	Parental alcohol use	0.88
	Parental cannabis	0.89
Other risk behaviours	Past month cannabis use	0.83
	Past month binge drinking	**0.78**
	Sexually active	0.86
Factors in combination	Home factors + parental substance use	0.88
	School factors	0.88
	Leisure factors	0.81
	Attitudes to substance use	**0.68**
	Past month cannabis & binge drinking combined	**0.71**
	All other risk behaviours combined	**0.67**

In summary, the included predictors only explained a small proportion of the rapid decline in adolescent smoking in the 2001-2007 period. Adolescent attitude to smoking was the only

factor that made a sizable independent contribution, and the majority of the decline was unexplained in the full model. In contrast, in the 2007-2012 period, the decline in adolescent smoking was almost completely accounted for by the factors in the model. Attitude to smoking continued to be an important independent contributor, but equally important was the combined effect of declines in the other risk behaviours, in particular binge drinking.

Cannabis use

As shown in Table 54, the odds of students using cannabis in 2007 compared with 2001 were 0.54 (0.44, 0.66), after adjusting for demographic factors (Model 1). The full model (Model 2), including all available predictors, produced and OR for year of 0.60 (0.46, 0.77), indicating that the included predictors explained little of the trend. However, as with tobacco use, there were 'counteracting' variables – attitude to cannabis, parental cannabis use and sexual activity – that reduced the proportion of the trend explained. When these factors were removed from the full model in a supplementary analysis, the fully adjusted OR was 0.82 (0.65, 1.04).

Past month tobacco use was the only factor that made a notable independent contribution to the cannabis trend in the first half of the study period. However the attenuation of the OR was only 6.6%. In combination, past month tobacco use and binge drinking made no greater contribution than past month tobacco use alone.

Interestingly, as noted above, after adjusting for all the other factors in the model, attitude to cannabis use appears to put *upward* pressure on cannabis use (i.e. the OR for year increased rather than decreased when this factor was dropped from the full model). The same can be seen in Table 55 showing the results for the 2007-2012 period. This might seem surprising given that the proportion of students condoning cannabis use declined over the study period (Chapter 7), but in fact it is consistent with the findings in Chapter 7. They showed that declining acceptability of cannabis use was largely explained by declines in past month smoking and drinking, and therefore was not independent of those factors. Furthermore, supplementary analysis showed that the relationship between cannabis attitudes and past month cannabis use strengthened significantly over the study period from OR 13.0 in 2001 to OR 16.4 in 2007 and OR 29.7 in 2012, also helping to explain this finding. It is harder to understand why parental cannabis use is putting upward pressure on adolescent cannabis use, since neither exposure to parental cannabis use nor its association with adolescent cannabis use increased significantly over the study period. This suggests that parental cannabis use

must have had increasingly strong associations with other risk factors in the model. Sexual activity also put strong upward pressure on cannabis use in the 2001-2007 period, which was expected since the proportion sexually active increased in the first half of the study period.

Table 54: Cannabis trend analysis, 2001-2007, full model

Model 0	OR 2007 (ref 2001) – unadjusted	0.49
Model 1	OR 2007 (ref 2001) – adjusted for demographics	0.54
Model 2	2007 (ref 2001) – fully adjusted	0.60
OR for 2007, full model (Model 2) EXCEPT the named variable(s)		
Home factors	Parental monitoring	0.60
	Fun with family	0.60
	Family relationship	0.61
	Maternal closeness	0.60
	Paternal closeness	0.60
	Maternal warmth	0.60
	Paternal warmth	0.59
School factors	Students are treated fairly	0.60
	Sense of belonging at school	0.60
	School expects me to do well	0.60
	Intention to complete school	0.60
	Plans after leaving school	0.60
Leisure factors	Part time job	0.59
Attitudes to substance use	OK to smoke regularly	0.59
	OK to drink regularly	0.60
	OK to use cannabis regularly	0.64
Parental substance use	Parental smoking	0.60
	Parental alcohol use	0.60
	Parental cannabis	0.64
Other risk behaviours	Past month tobacco use	0.56
	Past month binge drinking	0.59
	Sexually active	0.69
Factors in combination	Home factors + parental substance use	0.65
	School factors	0.60
	Attitudes to substance use	0.58
	Past month tobacco & binge drinking combined	0.56
	All other risk behaviours combined	0.69

Table 55 shows the results for the second half of the study period, showing a similar decline in cannabis use (OR 0.56, 95% CI 0.52, 0.61), but one that is entirely explained by the predictor variables in the full model (OR 0.96, 95% CI 0.86, 1.08).

Table 55: Cannabis trend analysis, 2007-2012, full model

Model 0	OR 2012 (ref 2007) – unadjusted	0.55
Model 1	OR 2012 (ref 2007) – adjusted for demographics	0.56
Model 2	2012 (ref 2007) – fully adjusted	0.96
OR for 2012, full model (Model 2) EXCEPT the named variable(s)		
Home/family factors	Parental monitoring	0.97
	Fun with family	0.96
	Family relationship	0.97
	Maternal closeness	0.97
	Paternal closeness	0.96
	Maternal warmth	0.96
	Paternal warmth	0.96
School/education factors	Students are treated fairly	0.97
	Sense of belonging at school	0.96
	School expects me to do well	0.97
	Intention to complete school	0.92
	Plans after leaving school	0.98
Leisure factors	Part time job	0.96
	Time hanging out with friends	0.93
Attitudes to substance use	OK to smoke regularly	0.96
	OK to drinking regularly	0.98
	OK to use cannabis regularly	1.11
Parental substance use	Parental smoking	0.96
	Parental alcohol use	0.96
	Parental cannabis	0.98
Other risk behaviours	Past month smoking	0.92
	Past month binge drinking	**0.85**
	Sexually active	0.92
Factors in combination	Home factors + parental substance use	0.93
	School factors	0.96
	Leisure factors	0.93
	Attitudes to substance use	1.02
	Past month smoking & binge drinking combined	**0.80**
	All other risk behaviours combined	**0.76**

Past month binge drinking was the strongest independent contributor to declining cannabis use in the 2007-2012 period, by a considerable margin. Minor contributing factors (each making an independent contribution of a similar magnitude) were past month smoking, proportion sexually active, time hanging out with friends and intention to complete school. When factors were grouped, other risk behaviours in combination made much the greatest independent contribution to declining cannabis use.

In summary, of the predictors included, past month smoking was the only major contributor to the decline in cannabis use in the first half of the study period, and most of the decline in cannabis use was unexplained by the full model. In contrast, in the second half of the study period, the full model fully accounted for the decline in cannabis use, with binge drinking the biggest single independent contributor. Past month smoking, sexual activity, intention to complete school and time hanging out with friends were also minor independent contributors.

Binge drinking

As shown in Table 56, the decline in binge drinking in the first half of the study period was relatively modest (Model 1: OR 0.76, 95% CI 0.65, 0.89). This downward trend was fully accounted for by the predictors in the full model (Model 2, OR 1.13, 95% CI 0.94, 1.35).

There was no single independent factor that stood out as the primary factor for the decline in binge drinking 2001-2007. Attitude to alcohol use and past month cannabis use were the strongest single independent factors, followed closely by attitude to smoking, parental alcohol use and past month smoking, which were all equally strong independent contributors. However, no single factor attenuated the OR by more than 8% when removed from the full model. When factors were grouped, attitudes to substance use and past month substance use (i.e. tobacco and cannabis) stood out as the most important factors, with home/parental factors (including parental substance use) also making a small independent contribution.

Table 56: Binge drinking trend analysis, 2001-2007, full model

Model 0	OR 2007 (ref 2001) – unadjusted	0.69
Model 1	OR 2007 (ref 2001) – adjusted for demographics	0.76
Model 2	2007 (ref 2001) – fully adjusted	1.13
OR for 2007, full model (Model 2) EXCEPT the named variable(s)		
Home factors	Parental monitoring	1.10
	Fun with family	1.12
	Family relationship	1.11
	Maternal closeness	1.13
	Paternal closeness	1.12
	Maternal warmth	1.11
	Paternal warmth	1.12
School/education factors	Students are treated fairly	1.11
	Sense of belonging at school	1.13
	School expects me to do well	1.13
	Intention to complete school	1.12
	Plans after leaving school	1.11
Part time job	Part time job	1.11
Student attitudes to substance use	OK to smoke regularly	1.09
	OK to drink regularly	1.05
	OK to use cannabis regularly	1.13
Parental substance use	Parental smoking	1.13
	Parental alcohol use	1.09
	Parental cannabis	1.13
Other risk behaviours	Past month tobacco use	1.09
	Past month cannabis	1.06
	Sexually active	1.26
Factors in combination	Home factors + parental substance use combined	1.07
	School factors combined	1.11
	Attitudinal factors combined	**0.94**
	Past month tobacco and cannabis combined	**1.01**
	All risk behaviours combined	1.17

In the second half of the study period (Table 57), binge drinking declined more substantially (OR 0.42, 95% CI 0.40, 0.44), and only a small proportion of the decline was explained by the predictors in the full model (OR 0.60, 95% CI 0.55, 0.64).

Table 57: Binge drinking trend analysis, 2007-2012, full model

Model 0	OR 2012 (ref 2007) – unadjusted	0.44
Model 1	OR 2012 (ref 2007) – adjusted for demographics	0.42
Model 2	2012 (ref 2007) – fully adjusted	0.60
OR for 2012, full model (Model 2) EXCEPT the named variable(s)		
Home factors	Parental monitoring	0.60
	Fun with family	0.60
	Family relationship	0.60
	Maternal closeness	0.59
	Paternal closeness	0.59
	Maternal warmth	0.60
	Paternal warmth	0.59
School factors	Students are treated fairly	0.60
	Sense of belonging at school	0.59
	School expects me to do well	0.59
	Intention to complete school	0.58
	Plans after leaving school	0.60
Leisure factors	Part time job	0.57
	Time hanging out with friends	0.58
Attitudes to substance use	OK to smoke regularly	0.59
	OK to drinking regularly	0.56
	OK to use cannabis regularly	0.59
Parental substance use	Parental smoking	0.59
	Parental alcohol use	0.59
	Parental cannabis	0.60
Other risk behaviours	Past month tobacco use	0.59
	Past month binge drinking	0.59
	Sexually active	0.59
Factors in combination	Home factors + parental substance use	0.58
	School factors	0.60
	Leisure factors	0.56
	Attitudinal factors	**0.54**
	Past month cannabis & tobacco smoking combined	0.58
	All risk behaviours combined	0.56

Again, there was no single factor that stood out as the primary independent contributor. Attitude to alcohol was the strongest independent factor (by a small margin) followed by part time job, time hanging out with friends, and intention to complete school. However none of these variables attenuated the trend by more than 7% when removed from the model. When the factors were grouped, attitudinal factors were the strongest independent contributor. Leisure factors (part time job, and time hanging out with friends) and other risk behaviours

(past month smoking, past month cannabis use and being sexually active) had independent effects of equal magnitude, and were the next strongest contributors to binge drinking decline. However none of these factors, individually or in combination, made a major contribution to the trend, most of which remained unexplained by the full model.

In summary, in the first half of the study period the decline in binge drinking was modest and fully explained by the predictors in the model, with attitudes to substance use and past month substance use (i.e. tobacco and cannabis) the strongest of a range of contributors. In the second half of the study period, the decline in binge drinking was much greater, and little of the decline was explained by the predictors in the full model. Attitudinal factors made the greatest independent contribution, but the majority of the decline was unexplained.

Sexual activity

Because the focus of this project is on *declining* risk behaviours, trend analysis of sexual activity (which did not decline in the first half of the study period) focuses on the results for 2007-2012. As indicated in Table 58, Model 1, the likelihood of being sexually active in 2012 compared to 2007 was 0.45 (95% CI 0.42, 0.47). Just over half of this decline was accounted for by the predictors in the full model (Model 2) OR 0.75 (0.69, 0.81).

Past month binge drinking and past month cannabis use were the strongest independent contributors to the decline in sexual activity in the second half of the study period. Part time job, intention to complete school and attitude to smoking were other factors that made small independent contributions. When grouped, past month substance use stood out as being the biggest contributor to the decline in sexual activity by a considerable margin. Leisure factors (time spent hanging out with friends and part time job) were the next most important, followed by attitudes to substance use.

Table 58: Sexual activity trend analysis 2007-2012, full model

Model 0	OR 2012 (ref 2007) – unadjusted	0.48
Model 1	OR 2012 (ref 2007) – adjusted for demographic factors	0.45
Model 2	2012 (ref 2007) – fully adjusted	0.75
OR for 2012, full model (Model 2) EXCEPT the named variable(s)		
Home factors	Parental monitoring	0.75
	Fun with family	0.74
	Family relationship	0.75
	Maternal closeness	0.74
	Paternal closeness	0.75
	Maternal warmth	0.75
	Paternal warmth	0.75
School factors	Students are treated fairly	0.75
	Sense of belonging at school	0.75
	School expects me to do well	0.75
	Intention to complete school	0.73
	Plans after leaving school	0.76
Leisure factors	Part time job	0.72
	Time hanging out with friends	0.74
Attitudes to substance use	OK to smoke regularly	0.73
	OK to drinking regularly	0.74
	OK to use cannabis regularly	0.75
Parental substance use	Parental smoking	0.74
	Parental alcohol use	0.75
	Parental cannabis	0.75
Other risk behaviours	Past month tobacco use	0.74
	Past month cannabis use	0.69
	Past month binge drinking	0.68
Factors in combination	Home + parental substance use	0.73
	School factors	0.75
	Leisure factors	0.70
	Attitudes to substance use	0.72
	Past month substance use (smoking, cannabis & binge drinking) combined	**0.59**

Discussion

The findings of Part 2 are summarised in Table 59. It shows that, overall, attitudes to substance use and declines in other risk behaviours were the strongest independent drivers of declining adolescent risk behaviours in New Zealand, 2001-2012. Importantly, the extent to which the included predictors accounted for the trends differed by risk behaviour and time period.

Table 59: Summary of trends, extent full model accounts for trends, and strongest contributors, 2001-2007 and 2007-2012

	2001-2007			2007-2012		
	OR for year partially adjusted	**OR for year full model**	**Strongest contributor(s)**	**OR for year partially adjusted**	**OR for year full model**	**Strongest contributors**
Past month smoking	0.46 (0.38, 0.56)	0.60 (0.47, 0.75)	Attitude to smoking	0.41 (0.38, 0.45)	0.89 (0.79, 1.01)	Attitude to smoking Other risk behaviours (esp. binge drinking)
Past month cannabis use	0.54 (0.44, 0.66)	0.60 (0.46, 0.77)	Past month smoking	0.56 (0.52, 0.61)	0.96 (0.86, 1.08)	Other risk behaviours (esp. binge drinking)
Past month binge drinking	0.76 (0.65, 0.89)	1.13 (0.94, 1.35)	Attitudes to substance use Past month cannabis use and smoking	0.42 (0.40, 0.44)	0.60 (0.55, 0.64)	Attitudes to substance use
Sexually active	-	-	-	0.45 (0.42, 0.47)	0.75 (0.69, 0.81)	Substance use (esp. binge drinking & cannabis)

All models are adjusted for age, sex, ethnicity and school decile

The importance of tobacco-specific and alcohol-specific factors, along with the fact that smoking declined strongly in the first half of the study period and binge drinking in the second, tends to suggest smoking and drinking are largely separate trends with separate drivers. The full model left the majority of the smoking and drinking trends unexplained, with the unexplained portion likely to be explained by factors specific to tobacco and alcohol (or both), since there is little unexplained cannabis or sexual activity decline to be explained by common factors.

The findings of Part 2 confirmed the findings of Chapter 6 – that the common drivers examined made minor, if any, independent contributions to adolescent risk behaviour trends. Leisure factors (the decline in part time work, and time hanging out with friends) appear to be more important, after adjustment, than home or school factors, at least in the second half of the study period. This provides some support for the idea that changes in how and where young people socialise may have contributed to risk behaviour trends. However, this appears to be a minor contributor, compared with the attitudinal and behavioural factors.

Smoking and binge drinking declines fully accounted for the decline in cannabis use in the second half of the study period, and declining substance use substantially explained the decline in sexual behaviour. As discussed, there are plausible causal mechanisms for knock on effects e.g. disinhibition due to the psychoactive effects of alcohol and cannabis; reduced opportunities for cannabis use and sex due to fewer drinking/smoking occasions; and economic complementarity between smoking, drinking and cannabis use due to customary use of these substances together.

Conclusions

One of my research questions set out in the introduction of this thesis was, do the concurrent declines in many adolescent risk behaviours represent a) a 'unitary trend' with common underlying drivers; b) separate trends with separate drivers, coincidentally occurring at the same time; or c) knock on effects from one risk behaviour to another? This chapter suggests that in the New Zealand context, it is a mixture of all three, with behaviour-specific factors and knock on effects being much more important than any of the common underlying drivers examined.

CHAPTER 9: DISCUSSION

If Millennials are different in one way or another, it's not because we're more (or less) evolved than our parents or grandparents; it's because they've changed the world in ways that have produced people like us.

(Malcom Harris, *Kids These Days*, 2017, p 4)

Introduction

My doctoral project set out to describe and explain trends in adolescent risk behaviours in the early 21st century, considering not only New Zealand but also other high-income countries that have seen dramatic declines in adolescent smoking, drinking, drug use and sexual behaviour over the past 15-20 years. To date, this shift has not been widely recognised within public health, much less explained.

In this chapter I summarise and discuss the findings of my thesis as a whole, reviewing my research questions and drawing conclusions where possible. I then discuss the theoretical and practical implications of my findings, and make recommendations for future research.

Statement of principal findings

While a full explanation for risk behaviour trends remains elusive, my work has contributed several important findings:

- Firstly, I have established that declining risk behaviour is a broad phenomenon comprising large and unprecedented changes in multiple adolescent behaviours that have occurred in many high-income countries. The patterns I have documented provide important clues as to the drivers of this megatrend.
- Secondly, I found that the age at which adolescents tried risk behaviours for the first time increased between 2007 and 2012 in New Zealand. This finding is consistent with US and Australian studies and indicates that increasing age of initiation (though not a causal explanation) is a factor in the observed decrease of risk behaviour in secondary students.
- Thirdly, my thesis provides clear evidence *against* several hypotheses. For example, I have demonstrated that increased parental monitoring, school attachment and tobacco taxation were *not* significant contributors to adolescent trends, at least in New

Zealand. Furthermore, international evidence refutes the hypothesis that digital media use has displaced risk behaviour.

- Fourthly, I found that declines in adolescent cannabis use and sexual activity in New Zealand were largely accounted for by declines in binge drinking and smoking. This is a novel finding which underlines the importance of investigating more than one risk behaviour at a time, and exploring the relationships between them.
- Finally, it appears that, internationally, common drivers, behaviour-specific factors and knock on effects have *all* played a role in the decline of adolescent risk behaviours. Common underlying drivers include a decline in unsupervised time with friends and increasing age of initiation. Behaviour specific factors include decreasing parental permissiveness towards youth drinking, and changing attitudes towards smoking and drinking among adolescents.

While on one level it is frustrating not to have found a clear answer to the question of why this dramatic shift in adolescent behaviour has occurred, my finding that there is no simple answer is an important finding in itself. To date, there has been a tendency to posit and test single drivers, drawing on linear cause and effect logic. Such research is valuable and adds to the evidence base, but my thesis suggests that the picture is much more complex, with multiple drivers and bi-directional relationships operating in a dynamic system. My thesis highlights both the importance for public health of tackling complex questions about how and why behaviour changes at the population level, and also the limitations of our current tools for dealing with complexity.

Summary of findings in relation to research questions

Research question 1

What are the key trends in adolescent sexual behaviour and substance use (tobacco, alcohol, cannabis) in New Zealand, Australia, England and USA, 1990-2017, and what do the patterns suggest about the possible drivers of risk behaviour decline?

This question was addressed in Chapter 3 where I collated existing data on trends in adolescent smoking, drinking, cannabis use, and sexual behaviour, highlighting the similarities and differences between countries, between different risk behaviours and between demographic groups. I briefly summarised trends in other adolescent health indicators, identifying those that do and do not conform to the general trend towards 'healthiness'. As

noted above, the patterns observed give important clues as to the nature and possible drivers of the shift in adolescent behaviour, and these are discussed below.

My descriptive analysis demonstrated that declining adolescent risk behaviour is an international phenomenon, with some striking similarities between trends in New Zealand, Australia, England and the USA. I found strong declines in a range of adolescent risk behaviours and outcomes including smoking, drinking, teen pregnancy, dangerous driving, juvenile crime, and physical fighting in many (but not all) high-income countries over the past 15 to 20 years. The patterns suggest a megatrend away from risky and delinquent behaviours in developed countries.

However there were no corresponding improvements in indicators such as obesity, physical activity, condom use or mental health – in fact there were significant declines in many of these indicators. This pattern suggests that young people have not become healthier or happier in general, nor does a trend towards healthy living explain population trends. If a fashion for healthy living was the cause of declining drinking and smoking among adolescents, we would also have seen an increase in the proportion meeting physical activity and fruit and vegetable intake recommendations over time. But, as discussed, in Chapter 3, this has not been the case.

Similarities across countries and behaviours are suggestive of broad socio-cultural changes impacting on many behaviours simultaneously, but other clues point towards the importance of behaviour-specific factors. For example, in New Zealand, Australia and England steep declines in adolescent tobacco use began in the mid- to late 1990s whereas strong declines in adolescent alcohol use did not occur until several years later, in the early to mid-2000s. This lag suggests separate behaviour-specific triggers, rather than (or working jointly with) common underlying drivers.

Similar trends are seen in countries with very different regulatory environments, suggesting that public health interventions are probably not the primary cause of declining risk behaviours. Preventive strategies (at least for alcohol, cannabis and sex) are broadly similar today to those in the 1990s – a period that saw substantial *increases* in risk behaviours. There was no major new preventive intervention introduced internationally in the late 1990s or early 2000s that could explain the patterns observed. However, we cannot discount the possibility that public health efforts have played an important contributory role, particularly in

smoking decline, since tobacco control has intensified markedly since the 1990s in most high income countries.

A notable pattern is that trends for adolescents are distinct from adult trends, at least for tobacco, binge drinking, and birth rates. This pattern suggests that drivers are either youth-specific (e.g. to do with parenting, school, youth culture or other factors that do not touch adult lives) or they are affecting young people differently from adults (e.g. labour market trends may have different material and psychological effects on adolescents than on adults). Whether we are seeing a generational change (i.e. a cohort effect) or merely delayed onset of risk behaviours (i.e. a change in age effect) is not yet certain, and remains an area for further research.

A common factor in the risk behaviours that have declined is that they are typically undertaken with friends when unsupervised, often at night. This suggests young people may be going out less frequently, and/or having less unsupervised time with friends. If so, this shift could be due to decreased adolescent interest in going out with friends (e.g. because online activities are more engaging) or external constraints (e.g. increased parental controls, less financial independence, greater school pressure), or both.

Declines in smoking, drinking, cannabis use and sexual activity have occurred in adolescents of all demographic groups (though not necessarily evenly) with minor, if any, lags between high and low socio-economic groups. This is surprising given the heterogeneity of adolescent contexts and lifestyles, and is not typical of how 'diffusion of innovations' generally occur i.e. slowly, and with high socio-economic groups taking the lead (Haider & Kreps 2004). While this pattern is suggestive of universal exposures (e.g. the digital revolution) being behind these trends, the fact that there are outlier countries (e.g. Italy) where adolescent risk behaviours are *not* declining indicates that universal exposures cannot be the primary cause in any direct sense. It seems more likely that broad cross-national influences are *interacting* with behaviour-specific factors and the existing culture/context in each country.

In summary, my descriptive analysis of trends shows that declining adolescent risk behaviour is an international phenomenon, with trends in adolescent smoking, drinking, drug use, pregnancy, road safety, crime, and physical fighting all potentially part of this megatrend which has occurred in many – but not all – high-income countries. Such a rapid and widespread shift in adolescent behaviour is unprecedented, and cannot be explained by public policy success alone. Nor can it be explained by healthy living becoming fashionable. The

patterns suggest that, whatever is causing the shift in adolescent behaviour, it is affecting adolescents in all demographic groups, but is not affecting adults in the same way. The patterns also suggest that both behaviour-specific factors and broad cross-national social or environmental changes may be important.

Research question 2

What does analysis of repeat cross sectional data from New Zealand reveal about the drivers of declining risk behaviour in secondary school students in this country?

Chapters 5 to 8 addressed this question. Using secondary analysis of nationally representative data, I tested hypothesised contributory factors that might account for declines in adolescent smoking, cannabis use, binge drinking and sexual activity among adolescents in New Zealand. As far as I am aware, it is the first systematic empirical investigation into the causes of declining adolescent risk behaviour in New Zealand. It is also among the first internationally to look at multiple risk behaviours and multiple potential contributing factors, thus allowing assessment of their relative importance.

Chapter 5 focused on smoking decline in Year 10 students aged 14-15, and used data from the annual ASH Year 10 Snapshot Survey 2002-2015 to explore the possible contribution of parental smoking, sibling smoking, best friend smoking, exposure to smoking in the home, and tobacco price. The findings contribute to the literature by providing evidence *against* several hypothesised contributors to the decline in adolescent smoking. It was plausible that changes in parental smoking, older sibling smoking and smoking in the home might have contributed to the decline in adolescent smoking observed at the population level, since these are all important predictors of adolescent smoking at the individual level, and exposure was likely to have declined due to the denormalisation of smoking. The findings of Chapter 5 demonstrate that this was not the case; in New Zealand from 2002 to 2015 adolescent smoking declined independently of these tobacco-specific factors.

It was also plausible that the increasing price of tobacco could have contributed to adolescent tobacco decline, since tobacco tax increases have been central to tobacco control efforts in New Zealand (and internationally) in recent years. However, ecological analysis suggests that tobacco tax probably played little or no role in smoking decline in this age group between 2002 and 2015. At best, tax increases may have contributed to a narrowing of socio-economic differences in adolescent smoking since 2010.

Only the decline in best friend smoking, the strongest individual-level risk factor for adolescent smoking, helped to account for the observed decline in adolescent smoking prevalence. Since respondents and their best friends were part of the same population in which smoking was declining, this provides a circular and therefore unsatisfactory explanation at the population level, based on linear cause and effect logic. However the findings of Chapter 5 highlight the fact that peer smoking is a very strong individual-level predictor, raising the possibility that a powerful feedback loop (with changes in adolescent smoking leading to further changes) may help to explain population-level fluctuations in teen smoking in recent decades. This possibility is discussed in more detail under research question 3 below.

Turning from smoking to risk behaviours more generally, in Chapters 6-8, I used secondary analysis of data from the Youth 2000 survey (2001, 2007 and 2012) to investigate a wide range of potential contributors to declines in smoking, cannabis use, binge drinking and sexual activity in secondary school students aged under 16. Chapter 6 focused on the possible contribution of common predictors, that is, factors such as parental monitoring, family connectedness, school connectedness, having a part time job and time spent hanging out with friends, which are known predictors of all four outcomes of interest. My results suggest that these common predictors, in combination, played only a very minor role in the decline of smoking, drinking, cannabis use and sexual activity in New Zealand adolescents over the study period. The finding that 'time hanging out with friends' did not significantly explain risk behaviour trends provides evidence against the digital media displacement hypothesis. If digital media was contributing to risk behaviour decline via a decrease in face to face socialising, we would expect to see a substantial change in time 'hanging out with friends' and empirical evidence that this was a statistically significant contributor to trends. This was not the case.

Chapter 7 explored the potential contribution of attitudes and norms. I used survival analysis to demonstrate empirically that that age of initiation for all four risk behaviours increased between 2007 and 2012. This finding is consistent with research from Australia and the USA showing that, after many years of decline, age norms for initiation of substance use and sexual intercourse have increased in recent years (Finer & Philbin 2014, Keyes et al. 2018, Livingston 2019). I found adolescent attitudes to substance use changed substantially over time, with a large decrease in the proportion of young people condoning regular smoking, drinking or cannabis use in people their own age. For example the proportion who thought it was OK for people their own age to smoke regularly halved between 2001 and 2007 and halved again

between 2007 and 2012, falling from 32% to 8% in just over a decade. The proportion approving of drinking fell by nearly two-thirds, from 42% to 16%, over the same period. I found that these declines in the acceptability of smoking and drinking were key contributors to the observed decline in all four risk behaviours. Reverse causality was considered, but supplementary analyses showed this was an unlikely explanation for the findings: for smoking and drinking attitudes explained behaviour much more than behaviour explained attitudes. I found parental substance use did *not* significantly contribute to adolescent risk behaviour trends, despite declines over time in the proportion of students reporting their parents smoked or drank alcohol at home.

Chapter 8 investigated the extent to which risk behaviour trends influenced one another. Importantly, I found that declines in cannabis use and sexual activity in 13-15 year olds were largely accounted for by declines in smoking and binge drinking. Furthermore, in the second half of the study period, declines in binge drinking contributed substantially to trends in all the other risk behaviours. Causality cannot be definitively determined, since my study rests on cross-sectional data, but, as discussed in Chapter 8, there are plausible causal mechanisms. These include reduced opportunities for cannabis use and sex due to fewer drinking/smoking occasions; economic complementarity between smoking, drinking and cannabis use due to customary use of these substances together; and a decrease in intoxicated decision making.

When all the included predictors from the Youth 2000 surveys were entered in full statistical models (Chapter 8), the majority of the declines in smoking and binge drinking remained unexplained. Clearly there must be other unmeasured (or unmeasurable) factors that account for the unexplained portion of the trends. The fact that the smoking and binge drinking trends remained largely unexplained – whereas trends for cannabis and sexual activity were substantially accounted for – suggests that the unknown drivers are not common to all behaviours but, rather, are likely to be alcohol- and tobacco-specific.

Taken together, my findings show that adolescent attitudes to tobacco and alcohol use, and trends in other adolescent risk behaviours were the most important identified contributors to risk behaviour declines in New Zealand adolescents. In the New Zealand context, trends in adolescent smoking and binge drinking appear to be primarily driven by tobacco-specific and alcohol-specific factors, respectively. In contrast, declines in cannabis use and sexual activity seem to be largely knock on effects resulting from declining smoking and binge drinking. Common underlying drivers in home, school and leisure contexts only made a very minor contribution. However, the pattern of findings in the latter half of the study period is

consistent with a decline in going out or 'partying' leading to reduced opportunities for all four risk behaviours.

Because New Zealand trends in adolescent risk behaviours (and underlying risk factors) are similar to those in many other high-income countries, my findings may be broadly generalisable to culturally similar countries that have observed similar trends. Certainly the role of adolescent attitudes and the possibility of knock on effects from one risk behaviour to another are worthy of investigation internationally.

Research question 3

What are the possible explanations for the international decline in adolescent risk behaviours? How plausible are these explanations, based on existing theory and evidence and the findings of my own empirical analyses?

My appraisal of explanatory hypotheses is based on the theory and evidence outlined in Chapters 2, 3, and 4 and the findings of my own empirical research presented in Chapters 5-8. Since a large number of hypotheses have been raised in the literature, this discussion focuses on those that have been most widely discussed, and those that are most plausible. I have divided hypothesised contributors into i) common drivers i.e. those influencing several risk behaviours simultaneously; ii) behaviour-specific factors i.e. those that affect a particular risk behaviour, and iii) knock on effects from one behaviour to another.

As previously noted, only a few of the possible explanations put forward in the literature have been empirically tested using trend analysis or similar. Those with evidence of impact on risk behaviour trends in the age group of interest, based on such rigorous testing, are summarised in Table 60.

The appraisal of the remaining hypotheses rests on less direct evidence, e.g. evidence of an association between the hypothesised driver and outcome of interest, a plausible causal mechanism, and evidence of changing exposure at the individual level, or temporal correspondence of trends at the ecological level. It is important to note that one of the findings of my research (consistent with other trend analyses, e.g. Grucza et al. 2017) is that even when a factor (e.g. parental monitoring) is strongly associated with risk behaviours and exposure changes significantly over the study period it does not necessarily account for risk behaviour trends. Therefore this less direct evidence can only be considered suggestive in the absence of more rigorous hypothesis testing.

Table 60: Population-level drivers of declining risk behaviour in adolescents, supported by robust empirical evidence

	Smoking	Alcohol	Cannabis use	Sexual activity
Common drivers	Decrease in face to face contact with peers in the evening (de Looze 2018) Changing age norms/later initiation of risk behaviours (Chpt 7, Finer 2014, Keyes 2018, Livingston 2019) Decline in a latent 'externalising-like' trait (Grucza, 2017)			
Behaviour specific factors	Declining adolescent approval of smoking (Chpt 7) Strength of tobacco control policy (White 2011)	Declining adolescent approval of drinking (Chpt 7) More restrictive parental rules about drinking/disapproval of adolescent drinking (De Looze 2014; de Looze 2017; Toumbourou 2018) Decline in perceived ease of access to alcohol (Raitasalo 2018; Toumbourou 2018) Strength of alcohol control policies (White 2018)		
Knock on effects	Declining binge drinking and cannabis use (Chpt 8) Declining cannabis use (Pampel & Aguila 2008)	Decrease in smoking (Chpt 8)	Decrease in binge drinking and smoking (Chpt 8, Fleming 2016, Miech 2017) Decreasing opportunities to try cannabis (Burdzovic 2017)	Decrease in substance use (Chapt 8)

Common drivers

Less unsupervised time and space

As noted in Table 60, a decline in face to face time with peers in the evening has occurred in many high income countries, and is empirically associated with declines in smoking, drinking and cannabis use at the national level (de Looze et al. 2019). Although there are many possible reasons why young people might be going out less, this finding is consistent with evidence that young people in early adolescence have less unsupervised time and space than those of previous generations. Adolescents of the 21st century are more likely to be accompanied by a parent on journeys to school and elsewhere (Shaw et al. 2013), less likely to hang out with friends in streets, parks or shopping centres (Travlou 2003, Karsten 2005, Twenge 2017), and less likely to be at home without an adult present (Twenge 2017). Therefore, it follows that opportunities for risk behaviours – which usually arise in such unsupervised contexts – are much less frequent.[20]

Arguably, the decline in unsupervised time and space reflects the cultural positioning of adolescents as both 'dangerous and in danger' (Moran-Ellis 2010). On one hand there appears to have been an 'extension of childhood' whereby society, parents, and even young people themselves increasingly view 12-15 year olds as children in need of close supervision and guidance, and protection from the dangers of the world. This is reflected in sharp declines in the proportion in this age group viewing substance use as acceptable in people their own age (Chapter 7) and in rising age of initiation for risk behaviours (Chapter 7, (Finer & Philbin 2014, Keyes et al. 2018, Livingston 2019).

On the other hand, increasing social anxiety about 'unruly' young people has led to policy responses such as prohibition of drinking in public places, Anti-Social Behaviour Orders in the UK, increasing CCTV surveillance, and use of the Mosquito[21] to deter young people from gathering in public places (Webb et al. 2004, Kelly 2010, McInroy 2010). Such policy responses intensified markedly from the early to mid-2000s in New Zealand, Australia, England and the USA, increasingly excluding young people from public space. Coupled with increasing

[20] While my New Zealand findings did not show 'time hanging out with friends' to be a significant contributor to risk behaviour decline, as discussed in Chapter 6 the broad question wording may not have picked up important changes over time in when and where young people hang out with friends and whether an adult was present. Thus, my findings are not necessarily inconsistent with the international research that suggests a decline in unsupervised time may be a key contributor.

[21] The Mosquito is marketed as 'an ultrasonic youth deterrent device'. It is a machine that emits a high frequency noise which is extremely unpleasant to young people, but outside the range of hearing for adults.

enforcement of age restrictions in bars and pubs, it is likely adolescents have fewer places to gather.

At the same time, more harmonious and egalitarian relationships between parents and adolescents in recent years (Brooks et al. 2015, Twenge 2017) may mean adolescents feel less need to 'escape' from the home environment. A shift in orientation away from parents and towards peers is part of the process of growing up, but this process may happen more slowly when parents are understanding, and when full independence from parents is temporally distant (de Looze 2013). Certainly, the average age at which young people leave home has risen markedly since 2000, making full independence very distant indeed for many 21st century adolescents.

Grucza et al (2017) demonstrated empirically that declines in substance abuse disorders and delinquency in US adolescents were not separate trends but linked by declines in a latent factor influencing all these behaviours (Table 60). The authors state 'the potential causes are likely to be environmental factors that have undergone relatively rapid changes in recent years' (p9). A decrease in unsupervised time and space could be just such a factor.

This hypothesis fits with both increasing mental health problems and declining risk behaviour observed in recent years. Unlike many other hypothesised common drivers, it is plausible that a decline in unsupervised time with friends could have opposite effects on mental health and risk behaviours.

Other plausible common drivers

There are other potential common drivers that have face validity and some supporting evidence but need further empirical investigation. These include a possible decrease in early life adversity and exposure to violence; a rise in risk aversion in young people; and a shift in the symbolic meaning of risk behaviours.

As discussed in Chapter 2, maltreatment in early childhood is strongly linked to many long-term negative outcomes including adolescent risk behaviours and delinquency. Encouragingly, there is evidence of a substantial and sustained decrease in child abuse and exposure to violence in the USA from the early 1990s (Finkelhor et al. 2014), which could help to explain the decline in adolescent risk behaviour from the late 1990s. Whether other high-income countries have also seen similar declines in child victimisation is unclear but New Zealand evidence suggests a decline in *adolescent* exposure to family violence and violent victimisation between 2001 and 2012 (Clark et al. 2013). The major global shift in social and professional

attitudes towards physical punishment of children since the 1990s (Straus 2010, D'Souza et al. 2016) is also likely to have decreased young people's cumulative exposure to violence, and improved their relationships with parents and other authority figures. However, we would also expect such changes to lead to improved adolescent mental health, so the fact that mental health has not improved counts against this hypothesis. Nonetheless, the hypothesis that decreasing exposure to violence and abuse has contributed to a shift in adolescent behaviour has some plausibility and is worthy of further research.

Sensation seeking and risk preference are strong predictors of risk behaviour at the individual level, as discussed in Chapter 2. Given the rise of 'risk society' (Beck 1992), including increasing social concern health and safety (Giddens 1999), it is possible that young people have become less willing to take risks and/or their perception of what is 'risky' may have expanded to include behaviours previously thought to be harmless. In the USA, trends in risk perception and risk preference have been researched, providing mixed evidence for this hypothesis. One study shows that prevalence of risk aversion in adolescents has increased since 2000 (Moss et al. 2019), whereas another shows that, on average, the desire to 'test oneself' or 'get a kick out of doing something a little bit dangerous' has been relatively stable among secondary school students since 2000 (Keyes et al. 2015). Although survey questions have remained consistent, ostensibly allowing valid comparisons over time, what is not captured is whether young people's *interpretation* of the questions has changed over time as a result of growing up in an increasingly risk-aware society. For example, experimentation with smoking and drinking may increasingly be considered 'dangerous' where once they were seen as harmless.

To some extent, this can be tested with reference to harm perception trends e.g. based on Monitoring the Future data (Johnston et al. 2016). The findings show that in the USA there is no general trend towards substance use being viewed as more harmful than it was in the past. Certainly, the proportion who view occasional smoking as harmful has increased markedly among US adolescents, but the perceived harmfulness of alcohol use increased only modestly, and the perceived harmfulness of cannabis use has declined dramatically in recent years. These diverging trends suggest that evolving product-specific beliefs may be more salient than an overall increase in risk perception or risk aversion.

Moffitt's and Jessor's influential theories (Jessor 1991, Moffitt 2006) highlight the *symbolic* and *functional* roles risk behaviours play in young people's lives. For example, to adolescents risk behaviours may symbolise independence and maturity, and function to enhance status

among peers. Qualitative research (and the fact that risk behaviours have declined so rapidly) suggests that drinking and smoking in particular may have lost their symbolic meaning as rites of passage or markers of 'coolness' (Törrönen et al. 2019). Further research is needed to explore how the social meanings of various risk behaviours may have changed over the past 15-20 years. But such shifts are certainly plausible given the major economic, cultural and technological changes that have impacted young people's lives in recent years (Chapter 2).

The digital revolution

Screen time and digital media engagement have undoubtedly increased dramatically since the turn of the 21st century (Bucksch et al. 2016), but there is consistent evidence *against* the hypothesis that mobile phones, social media, internet use or smartphones have displaced risk behaviour in terms of time use. Firstly, the beginning of the decline in adolescent risk behaviour (late 1990s) predates the rise of social media (approx. 2007) by almost a decade. Mass penetration of smart phones (from approximately 2012) is even more recent, and cannot explain the sharp declines in risk behaviours seen in the first decade of the 21st century. Secondly, the idea of displacement is predicated on the assumption that risk behaviour and digital media engagement are substitutes: more of one results in less of the other. But as discussed in Chapter 4 there is consistent evidence that they are in fact complements: those heavily engaged in one are likely to be heavily engaged in the other, with evidence of a dose-response relationship (Koivusilta et al. 2005, Peretti-Watel et al. 2009, Osaki et al. 2012, Gommans et al. 2015, Meldrum & Clark 2015). Thirdly, at the country level, research shows that there is no association between trends in electronic media communication and trends in substance use among adolescents (de Looze et al. 2019). This fits with the earlier observation that there are outlier countries such as Italy in which adolescent risk behaviour has not declined, despite the digital revolution. Based on a sizable and consistent body of evidence, it is reasonable to reject the hypothesis that virtual socialising has displaced face to face socialising and thereby reduced risk behaviour. The evidence suggests that risk behaviours have declined *in spite of*, not because of, young people spending more time online (de Looze et al. 2019).

However, the evidence does not exclude the possibility that the rise of social media, gaming and digital media more broadly may have changed adolescents' collective tastes, priorities and systems of meaning making, potentially contributing to a shift in the cultural position of drinking and other risk behaviours in some countries. If the previous functions of risk behaviours are increasingly being fulfilled by gaming and social media, then drinking and other

risk behaviours may have become less central to youth culture. If so, this would influence an adolescent's likelihood of engaging in risk behaviours regardless of his or her personal level of digital media use. This idea, which links to the hypothesis above about the changing symbolic meaning of risk behaviours, is somewhat speculative but is supported by qualitative evidence that youth priorities have diversified, de-centring the cultural position of alcohol (Törrönen et al. 2019). So while digital media has clearly not displaced risk behaviour in terms of individuals' time use, it is possible that it may have contributed to changes in youth culture and the social meaning of risk behaviours.

Other less plausible common drivers

There are other hypothesised common drivers that are unlikely to explain the major shifts we have seen in adolescent behaviours in recent years. For example, references to alcohol and illicit drug use in music lyrics have *increased* in recent years (Diamond et al. 2006, Hardcastle et al. 2013) so 'cleaner' popular culture influences are very unlikely to explain the trends. As discussed in more detail elsewhere, we can also reject the hypotheses that a healthy living trend (Chapter 3), immigration (Chapter 4), declining lead exposure (Chapter 4) or effective drug treatment of behavioural problems (Chapter 4) are key drivers of declining adolescent risk behaviours at the population level. At best these factors may be minor contributors, influencing specific groups of young people, but they cannot explain the broad and dramatic population level changes seen concurrently in many high-income countries.

Behaviour-specific drivers

There is considerable evidence, discussed below, that behaviour-specific factors are likely to account for a significant proportion of the observed declines in adolescent smoking and alcohol use. However, behaviour-specific factors appear to have made little or no contribution to declines in cannabis use or sexual activity.

Tobacco

Adolescent attitudes

Most of the tobacco-specific factors I tested proved not to be significant contributors to adolescent smoking decline (Chapter 5). Having said that, the most important determinant of adolescent smoking decline identified in New Zealand was a tobacco-specific factor: declining adolescent approval of smoking in people their own age (Chapters 7 and 8). This fits with the possibility presented above: that norms and social meanings surrounding tobacco use appear to have changed. I have identified several other plausible tobacco-specific factors that have

not yet been rigorously tested for their contribution to adolescent smoking decline, either in New Zealand or internationally. These are discussed below.

Peer feedback loop

I found that best friend smoking was by far the strongest determinant of adolescent smoking at the individual level and the only factor (of those tested) that helped to account for adolescent smoking trends. As discussed in Chapter 5 and above, this raises the possibility that initially small changes in adolescent smoking prevalence may be amplified over time via a peer feedback loop. For example a decline in the prevalence of adolescent smoking at $time_1$ would result in fewer adolescents supplying tobacco to peers and influencing friends to smoke, which would result in a further decline in the prevalence of adolescent smoking at $time_2$ and so on. A peer feedback loop could potentially account both for the sharp rises in adolescent smoking in the early 1990s and declines from the late 1990s: once triggered, adolescent trends may be self-reinforcing.

While it is highly plausible, and potentially applicable to other risk behaviour trends too, this peer feedback loop hypothesis remains to be tested. However it is consistent with diffusion of innovations (Haider & Kreps 2004) and social contagion theory (Christakis & Fowler 2013) which theorise how behaviours spread in a social network. Since regression techniques do not allow us to incorporate the effects of feedback loops or reciprocity, testing would require the application of methods for complex system modelling that have not yet been widely used in public health (Galea et al. 2009, Azar 2012, Carey et al. 2015). However, if empirically verified, peer feedback loops may help to explain sharp fluctuations in adolescent behaviours (not only smoking) that are 'out of step' with general population trends.

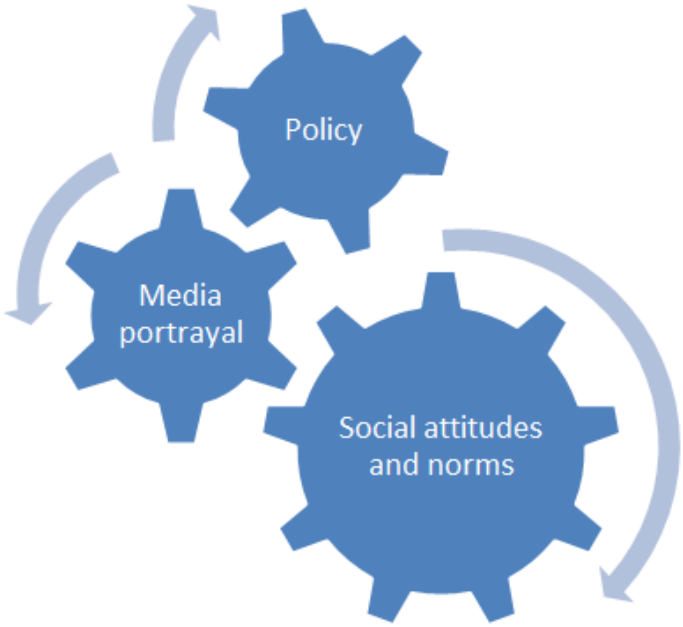
Denormalisation

Even assuming the peer feedback loop hypothesis is correct, however, the trigger for the late 1990s turning point from rising to falling adolescent smoking remains to be identified. As discussed in Chapter 5 there was no common policy measure implemented internationally in the mid- to late 1990s to trigger adolescent smoking decline. However all the countries of interest responded to the rise of teen smoking in the 1990s with public concern and an intensification of youth-focused policies. I have argued that tobacco denormalisation, rather than the direct effects of any specific tobacco control policies, may have been an important factor in the decline of adolescent smoking in the late 1990s and early 2000s. Following Chapman (Chapman 2003) I conceptualise denormalisation as a complex mutually reinforcing

web of changing social attitudes and norms, changing policy environment, and negative portrayal of smoking in the media, as illustrated in Figure 63.

Within public health we tend to focus on direct policy effects on behaviour, but arguably the findings of my thesis suggest that changes in social attitudes and norms may be more important determinants of adolescent behaviour. However, policy changes are still potentially important. Indeed, White et al (2011) demonstrated empirically that the strengthening of population-based tobacco control policies in Australia was associated with declining adolescent smoking prevalence. But as Chapman points out, it may be impossible to disentangle policy effects from broader denormalisation effects in such studies (Chapman 2003). An ongoing, mutually reinforcing relationship between public policy and social attitudes may be pivotal in the denormalisation process. For example, reduced social acceptability of smoking creates a political environment in which tobacco control policies can be enacted, which in turn further denormalises smoking. While the strengthening of tobacco control policy may be an important element, it is but one element in the denormalisation process.

Figure 63: Mutually reinforcing elements of the denormalisation process



Tobacco-specific parenting

The international finding that alcohol-specific parenting has been an important contributor to the decline in youth drinking (Table 60) may be transferable to tobacco-specific parenting.

Tobacco-specific parenting factors (e.g. anti-smoking attitudes, rules and expectations) are known to be an important determinant of adolescent smoking (Waa et al. 2011). Given the denormalisation of smoking discussed above, it is highly likely that parents have become less permissive about adolescent smoking over time. While the Youth 2000 survey did not include questions on tobacco-specific parenting, other surveys (in New Zealand and internationally) do include such questions, making this a plausible and testable hypothesis.

Ease of access to tobacco

Similarly, ease of access, which has been shown to be an explanatory factor for adolescent drinking trends (Table 60), may also be a determinant of adolescent smoking trends. Younger adolescents typically access tobacco via family and friends, so ease of access is likely to diminish as smoking becomes less prevalent. Evidence suggests that perceived ease of access has indeed declined, coinciding with the decline in adolescent smoking. For example Monitoring the Future data show that in the early to mid-1990s about three quarters of US 13-14 year olds reported they could get cigarettes easily if they wanted to. This proportion declined steadily from 1997 to 2016 when less than half reported easy access to tobacco (Johnston et al. 2016). Again, this hypothesis is plausible and testable, both in New Zealand and internationally.

Alcohol

Alcohol-specific parenting and adolescent attitudes

Alcohol-specific parenting factors have been shown to play a key role in the decline in adolescent drinking in many countries (Table 60). This is one of the clearest and most consistent findings to date, internationally, in the field of risk behaviour decline. My findings have also highlighted the importance of another alcohol-specific factor: declining adolescent approval of alcohol use in people their own age (Chapters 7 and 8).

Ease of access to alcohol

As noted in Table 60, declining ease of access to alcohol has also been shown to be a contributing factor, at least in Australia (Toumbourou et al. 2018b) and Finland (Raitasalo et al. 2018). There is also evidence from the USA that perceived ease of access to alcohol has declined over time, particularly among younger adolescents (Johnston et al. 2016). Declining ease of access is likely due, in part, to a decline in parental supply of alcohol (Kelly et al. 2016) which fits with the finding that parents are becoming less permissive regarding adolescent drinking. A decline in the prevalence of adolescent drinking is also likely to lead to a decline in supply of alcohol by peers (and thereby perceived ease of access) potentially creating a peer feedback loop, as discussed above.

Denormalisation

It seems unlikely that alcohol policy has been a major driver of the decline in adolescent drinking internationally since any restrictions introduced since 2000 have been fairly minor compared with major liberalisation in 1990s and preceding decades (Huckle et al. 2006). In some countries liberalisation has continued in the 2000s, including tax cuts in Finland (Lintonen et al. 2013) and increased opening hours of licenced premises in England and Wales (Durnford et al. 2008).

However, even in the absence of significant restrictive policy changes, it is possible that denormalisation of alcohol (as described above in Figure 63) has occurred in many high-income countries. This has likely been triggered by public concerns about alcohol harm (including perceived increases in violence and public disorder), coupled with new scientific findings about the adolescent brain and the health impacts of even moderate alcohol use, which have been widely reported in the media. Concerns about alcohol harm have led to considerable public debate about appropriate policy responses, for example New Zealand's Law Commission Review (Law Commission 2009, Law Commission 2010). Even where such debate has not resulted in substantive policy change (as was the case in New Zealand), the debate itself may reinforce public concerns and contribute to changing social norms (in particular, parenting norms and age norms) in relation to alcohol. It is notable that although alcohol harm is by no means limited to young people, problematic alcohol use is often framed as a youth issue in the media. This could explain why denormalisation (if indeed it has occurred) has influenced parental and adolescent attitudes and practices, but has not resulted in significant drinking decline in older age groups (Chapter 3).

This denormalisation hypothesis is supported by evidence of changing social attitudes towards alcohol (Livingston & Callinan 2017), and less favourable media depiction (Azar et al. 2014) in Australia. There have also been substantive policy changes in Australia including the introduction of an alcopops tax, laws against supplying alcohol to minors, and, more recently, reduction of trading hours of licenced premises in specific night-time entertainment areas of some cities. White et al (2018) found that the strengthening of alcohol restrictions in Australia in recent years was associated with declines in adolescent alcohol use at the population level. But importantly, the authors argued that direct policy effects were not always plausible, and that the signalling effect and public debate surrounding policies were likely to have influenced young people 'through perceptions of alcohol availability and social acceptability' (p1038).

While there is evidence of alcohol denormalisation in Australia, whether the same processes have occurred in other countries is yet to be investigated. Certainly it is important to look beyond policy measures and their direct effects, and consider possible mutually reinforcing relationships between media coverage, public concerns and social norms in relation to alcohol.

Cannabis and sexual activity

I did not identify cannabis-specific or sexuality-specific factors that were likely to have contributed to declines in adolescent engagement in these behaviours. On the contrary, social changes in relation to cannabis and sex seem more likely to have put *upward* pressure on these behaviours. For example, in many countries there has been liberalisation of legal restrictions on cannabis use (or debate about such liberalisation), relaxation of social attitudes towards cannabis, and a decrease in its perceived harmfulness (Fleming et al. 2016, Johnston et al. 2016, New Zealand Drug Foundation 2019).

Sexuality-specific social changes such as the rise of dating and hook-up apps such as Tinder (Quiroz 2013) and the increasing availability of pornography via the internet would also appear to be putting *upward* rather than downward pressure on adolescent sexual activity (Owens et al. 2012). As discussed in Chapter 4, although increased access to high quality and comprehensive sex education could (theoretically) lead to later sexual debut, there is no evidence that access to such education has increased. It is also possible that changing parenting practices surrounding sexuality (e.g. more open communication with adolescents about sex and sexual relationships) could have influenced adolescent behaviour, but I am not aware of any evidence of such a change.

In summary, it is likely that adolescent cannabis and sexual activity have declined *in spite of*, not because of cannabis-specific and sexuality-specific factors. It appears that knock on effects, discussed below, provide a more plausible explanation for declines in these risk behaviours.

Knock on effects

As noted in Table 60 and discussed in relation to Research question 2 above, my findings show that trends in adolescent risk behaviours are related to one another. In particular I found that declines in cannabis use and sexual behaviour were largely explained by declines in smoking and drinking, suggestive of knock on effects.

As discussed in detail in Chapter 8, my findings are consistent with international research showing that adolescent cannabis and tobacco trends are related (Pampel & Aguilar 2008), and that smoking and drinking trends influence opportunities for cannabis use (Fleming et al. 2016, Burdzovic & Bretteville-Jensen 2017, Miech et al. 2017). US research also suggests that declines in binge drinking lead to declines in (unprotected) sexual activity (Chesson et al. 2000, Carpenter 2005).

While none of these studies definitively proves a causal relationship between one risk behaviour and another, causal relationships are highly plausible, particularly between binge drinking and other risk behaviours (Chapter 8). Drinking has, at least until recently, been a central element in the social life of young people, and drinking occasions have typically provided opportunities to experiment with other substances, and meet sexual partners. Drinking also lowers inhibitions and affects judgement, explaining its strong association with sexual risk taking, dangerous driving, violence and crime. Therefore it follows that a decline in binge drinking will result in declines in a wide range of risk behaviours.

My thesis is one of the first studies, internationally, to consider impacts of risk behaviour trends on one another. Although the results are difficult to interpret, due to uncertainty about whether relationships are causal or due to common liability, it is clear that the declines are related. Further investigation of the relationships between trends in various risk behaviours is an important area of future research on adolescent risk behaviour decline.

Research question 4

Do the observed declines represent a *single* trend with common underlying driver(s); *separate* trends with separate drivers; or *knock on* effects from one risk behaviour to another?

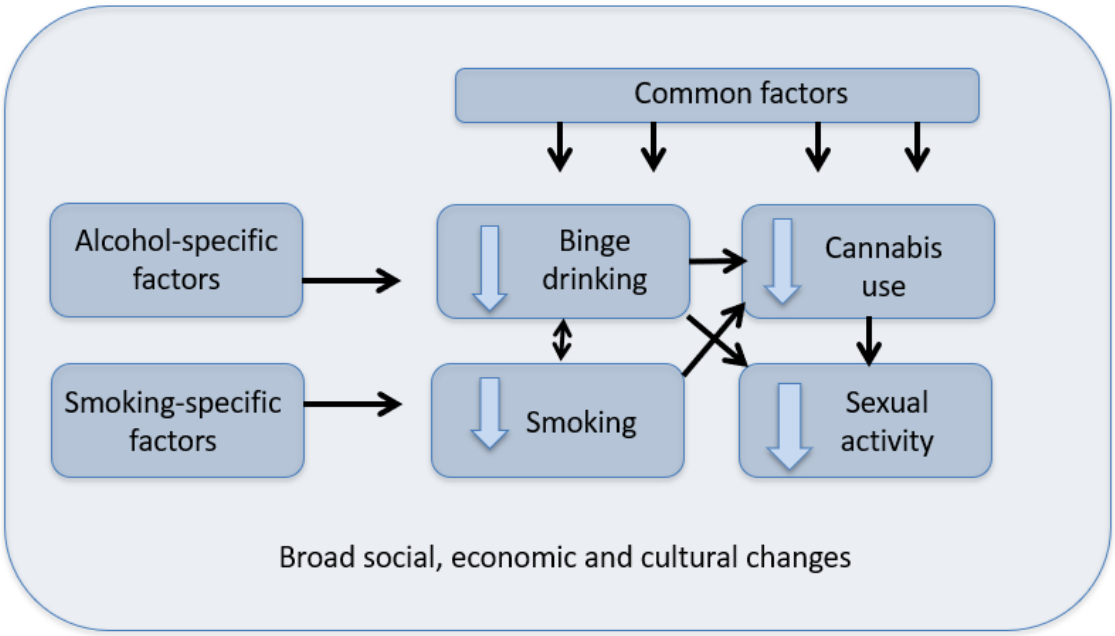
At the broadest level, these are the three possible explanations for the observed declines in adolescent risk behaviours. In the New Zealand context, as discussed above, adolescent risk behaviour decline appears to be driven a combination of all three, with separate trends and knock on effects the primary drivers. This is presented diagrammatically in Figure 64.

My findings suggest that declines in adolescent smoking and binge drinking are largely separate trends, driven by tobacco-specific and alcohol-specific drivers (albeit with each trend influencing the other to some degree). I found that declines in cannabis use and sexual activity were largely explained by declines in smoking and binge drinking, and I have argued that this

is (at least partially) a causal relationship. The combined effect of the common factors I tested (e.g. parental monitoring, school attachment, time hanging out with friends) was minor. This is consistent with international studies which have found general parenting and school factors were not significant contributors to risk behaviour trends (Grucza et al. 2016, Larm et al. 2018, Toumbourou et al. 2018b). However, as discussed above, there are other potential common factors which were not tested in my research.

These findings do not necessarily mean that broad social, economic and cultural changes, as outlined in Chapter 2, are unimportant. On the contrary, contextual changes that affect adolescents' (and their parents') world views may be crucial for creating an environment in which more proximal drivers arise or have an effect. For example, the emergence of 'risk society' (Beck 1992, Giddens 1999) characterised by increasing focus on harm prevention and growing anxiety about issues such as pollution and toxins, may have created an environment in which adolescents are primed to view tobacco and alcohol as threats rather than (forbidden) pleasures. Therefore we should not dismiss the importance of broad contextual factors, even if it is difficult to demonstrate their effects empirically.

Figure 64: Hypothesised relationship between factors influencing adolescent risk behaviour trends at the population level



My findings contrast with those of Grucza et al (2017) who concluded that a common underlying driver (or drivers) was the main cause of concurrent declines in a range of

substance use disorders and delinquent behaviours in US adolescents. The authors did not discount that behaviour-specific factors played a role but concluded that their influence was minor compared to that of common drivers. This apparent discrepancy in findings between the USA and New Zealand could reflect national differences in the drivers of adolescent risk behaviour decline. More likely, though, it reflects the fact that the US study was investigating the more severe end of the risk behaviour spectrum – clinically diagnosable substance use disorders and serious acts of delinquency – whereas my New Zealand study also included minor and low-level risk behaviours, e.g. smoking once a month. It is plausible that more severe risk behaviour (which is often symptomatic of underlying psychosocial problems) is primarily underpinned by common factors such as exposure to adversity and violence, whereas low-level risk behaviour is more influenced by social norms and adolescent perceptions specific to that behaviour.

In conclusion, it is likely that common drivers, behaviour-specific factors and knock on effects have all played a role in the decline of adolescent risk behaviours internationally. The relative importance of each may differ for severe versus low-level risk behaviour. These findings have important implications for policy and practice which are discussed further below.

Summary: What is driving risk behaviour decline?

Although the evidence base is still very limited, a picture of some of the key drivers of risk behaviour decline is beginning to emerge. The empirically-established contributors identified thus far are mainly tobacco-specific and alcohol-specific factors such as parental rules and expectations, decreasing ease of access, and decreasing adolescent approval of smoking and drinking. Knock on effects from one risk behaviour to another also appear to be important, with evidence both from my own research and international studies that declining smoking and drinking may have knock on effects to cannabis use and sexual activity in this age group (de Looze et al. 2012, Fleming et al. 2016, Miech et al. 2017). In many high-income countries, adolescents are going out with their friends in the evenings less frequently and this appears to be a common driver underlying declines in many risk behaviours. It seems likely that broad social changes have created a milieu in which these more proximal factors have emerged. However, much remains unknown, and my thesis highlights a number of plausible hypotheses worthy of further investigation.

Strengths and limitations

I have discussed methodological strengths and limitations of each empirical component of my thesis in the relevant chapter. To avoid repetition, I will focus here on major points, considering the overall approach taken in this thesis.

The broad scope of my doctoral project can be seen as both a limitation and a strength. On one hand there is a risk of insufficient depth and nuance when undertaking such a broad project, but on the other hand there is a risk of missing the bigger picture if one limits oneself to a narrow and 'manageable' scope. In this thesis I have documented major shifts in a range of adolescent risk behaviours that have occurred internationally. It was only by stepping back and looking at trends across multiple behavioural domains and in many countries that this megatrend became apparent. Once it became apparent, the next question was unavoidable: Why? Posing this bold question has led to some important findings with significant implications for theory and practice. It has also laid the groundwork for further research by collating what is already known, highlighting knowledge gaps, and putting forward new hypotheses and models to be tested.

A strength of my thesis is the interdisciplinary approach I have taken, drawing on theory and evidence from developmental psychology, sociology, economics and criminology as well as public health to understand the social and developmental context for adolescent risk behaviour, and how that context has changed over time. Combining insights from other disciplines with epidemiological rigour has proven to be illuminating and fruitful.

My study is one of very few to empirically test the contribution of a wide range of potential explanatory factors on several risk behaviours: smoking, binge drinking, cannabis use and underage sex. This has enabled me to investigate the relative importance of contributors, and the impact of risk behaviour trends on one another.

While there is value in examining broad population-level trends and their drivers, to generalise about the behaviour of whole generations is inherently problematic. Adolescents and their life experiences are heterogeneous, and population averages belie this heterogeneity. A limitation of my thesis is that, other than examining Māori and non-Māori tobacco trends and tobacco-specific drivers in Chapter 5, I have not investigated how trends and drivers differ between population groups. Risk behaviours are likely to have different social meanings and perform different functions depending on gender, ethnicity, culture and

social position, and may also differ in youth subcultures or 'peer crowds' (La Greca et al. 2001, ter Bogt et al. 2012). Therefore more detailed subgroup analysis is an important area for future research. It is especially important to explore influences on trends in groups that have a high prevalence of risk behaviours and bear a disproportionate burden of related harm, to inform efforts to decrease health disparities.

I used data from large, nationally representative repeat cross-sectional surveys. Such data provides the opportunity to examine trends over time in a given age group and, using regression analysis, investigate the extent to which individual-level variables account for these trends in statistical terms. An important limitation to consider when interpreting my empirical findings is that the analysis is based on cross-sectional data and therefore causality is uncertain. However, in interpreting the findings I drew on a body of existing theory and evidence from longitudinal and experimental studies about the aetiology of risk behaviour. Therefore my conclusions are based on careful weighing of the balance of evidence, and do not rest on my own empirical findings alone.

When multiple tests of statistical significance are performed, some statistically significant effects are likely to appear purely by chance. I am confident that my findings are not affected by the problem of multiple comparisons for the following reasons. Firstly, selection of potential explanatory factors was based on existing theory and evidence, not on data mining. Secondly, associations between the potential explanatory factors and the outcomes of interest was very strong in all cases ($p<.001$) and consistent with previous research. Thirdly, my interpretation of trend analyses did not rest on significance tests but on the overall *pattern* of results.

Many of the indicators I used in my descriptive analysis (Chapter 3) and secondary analysis of New Zealand data (Chapters 5-8) rely on self-report data, which may be influenced by social desirability. Therefore observed trends could potentially reflect changes in perceived acceptability of risk behaviours (or perceived confidentiality of survey instruments), rather than changes in the behaviour itself.

Although social desirability bias cannot be completely ruled out and may have contributed to observed trends, there are several reasons for believing that the observed changes are real. Firstly, the substantial size and consistency of the observed changes makes it unlikely they are simply artefacts. Secondly, a large body of research has tested the validity of adolescent self-reports of risk behaviour and, where behaviours can be validated via biochemical testing,

studies have generally shown strong agreement between self-reported and biochemical measures of substance use (Brener et al. 2003, Sunseri & White 2017). Thirdly, objective measures of risk behaviour such as births, abortions and traffic crash rates follow a similar pattern to self-reported data, with significant declines since the turn of the 21st century in the countries of interest.

A further data limitation was missing data for the four outcomes of interest in my Youth 2000 analyses (Chapters 6-8). The nature and implications of this missing data problem are discussed in detail in Appendix B. I conducted sensitivity analyses to determine the parameters of the potential effect of missing data, and these analyses showed that my key findings were robust to even extreme assumptions. Where sensitivity analysis suggested specific results should be treated with caution, this has been clearly stated in the body of the thesis.

Finally, regression analysis, as discussed above, is a powerful tool that enables empirical investigation of the characteristics of adolescents, their friends and family and the contexts in which they live, and how these variables contribute to risk behaviour trends in statistical terms. However, regression models are not well suited to dealing with complexity. They cannot take into account the reciprocal relationships, feedback loops, or developmental cascades that characterise the "real world" in which adolescent risk behaviour occurs (Galea et al. 2009). This inability to deal, mathematically, with real world complexity is a limitation of my research, and indeed of most epidemiological research to date (Stallones 1980, Carey et al. 2015).

In summary, both the data and the methods used in my thesis are imperfect. However, I have mitigated issues where possible and been transparent about limitations where appropriate. My approach has several strengths in relation to other studies conducted in this field and my findings add to what is known about the drivers of risk behaviour decline. They help to map what is a very new area of research, provide direction for future research, and have important practical and theoretical implications, discussed further below.

Theoretical implications

The findings of my thesis underscore the strong links between trends in different adolescent risk behaviours. In this sense my findings support Jessor's psychosocial framework for understanding adolescent risk behaviour (Jessor 1991).This framework, as discussed in

Chapter 2, posits that smoking, drinking, drug use and precocious sexual activity are not entirely separate behaviours but cluster in an organised pattern reflecting a certain lifestyle or 'way of being in the world' (p600). Moffitt too conceptualises such behaviours as fundamentally linked (Moffitt 2006), with both theorists emphasising the functional role risk behaviours play (e.g. to assert independence from parents and gain peer esteem) as central to their clustering. Jessor also emphasises the 'social ecology' of adolescent life, and identifies an array of factors in many domains e.g. genetics, personality, social environment and perceived norms, that influence adolescent behaviour. Jessor posits a complex 'web of causation' for adolescent risk behaviour, and my findings support his contention that determinants of adolescent behaviour are multiple, exist at many levels, and are characterised by complex and interacting (rather than linear) relationships.

Yet the fact that smoking, drinking and other risk behaviours – previously synonymous with youth culture and 'intractable to change' (Jessor, 1991, p591) – have declined so dramatically in a relatively short timeframe presents important challenges to received theories on adolescent risk behaviour. For example, according to Jessor's framework, substance use and mental health problems 'should' follow similar trends, since they share common underlying drivers. Yet mental health problems among adolescents – particularly girls – appear to be increasing at an alarming rate in some countries (Bor et al. 2014, Wise 2016, Kalb et al. 2019, Keyes et al. 2019) while prevalence of smoking, drinking and other risk behaviours plummet.

As shown in Chapter 6, exposure to known underlying drivers (family attachment, parental monitoring, school attachment etc) have largely moved in the 'right' direction. But these changes appear to have contributed little to the decline in risk behaviour, and have not prevented mental health problems. As argued above, these factors may in fact be more important to risk behaviour decline than empirical findings suggest, and of course there are common drivers that were not tested in my study. Yet my findings, along with adolescent trends themselves, put Jessor's framework into question. They suggest that common underlying drivers may be less important than behaviour-specific factors, and knock on effects from one risk behaviour to another, for explaining teen trends.

They also challenge the 'maturity gap' component of Moffit's theory i.e. that antisocial behaviour arises because young people reach biological maturity long before society allows them full autonomy or adult roles. Moffitt argues that this creates psychological discomfort and desire to assert autonomy and to reject childhood. Risk behaviours fulfil these desires because of their symbolic 'adult-like' status. The fact that risk behaviours became more

prevalent in the 1990s coinciding with an increase in the maturity gap (i.e. a marked increase in the average age at which young people left school, got jobs and became parents) fits with this theory. However since 2000 the maturity gap has increased even further, yet risk behaviours and delinquency – rather than increasing – have declined dramatically. As discussed in Chapter 4 and elsewhere, this could suggest that that risk behaviours no longer hold the same symbolic meaning they once did, or that today's adolescents have less desire to reject childhood and assert autonomy than previous generations. In either case, recent evidence suggests that the gap between biological maturity and achievement of adult roles does not inevitably give rise to rebellion or risk behaviour.

These examples show that the patterns we are seeing in the early 21st century do not sit comfortably with existing theory and knowledge about adolescent risk behaviour. It seems that much of what we 'know' is wrong, or at least outdated. The challenges to Jessor's and Moffit's theories discussed above illustrate that received understandings about the aetiology of adolescent risk behaviours, based as they are on research from the 1970s-1990s, may be much more culturally and historically specific than previously supposed. This presents a major challenge for those attempting to understand the drivers of recent trends, as there is little theoretical 'firm ground' on which to stand. We are faced with a need to update, and where necessary, build new frameworks and theories to make sense of adolescent behaviour in the 21st century.

Implications for future research

Understanding why adolescent risk behaviours are declining is essential if we are to capitalise on these trends for public health benefit. Such understanding would help to ensure that positive trends can be supported to continue, and may suggest strategies for creating behaviour change in geographical areas or demographic subgroups in which risk behaviours remain prevalent. Importantly, understanding how and why major behavioural shifts occur at the population level could provide insights applicable to a wide range of pressing public health and social problems, e.g. transforming behaviour to avert climate change.

Since investigation of the drivers of risk behaviour decline is still in its infancy, further research opportunities are wide open. Throughout my thesis I have highlighted numerous knowledge gaps and ideas worthy of further exploration. Here I focus on what I see as the most important next steps to progressing knowledge about the recent shift in adolescent behaviour, both in New Zealand and internationally.

Many of the factors known to have contributed to trends overseas, or identified as highly plausible contributors, have not yet been tested in the New Zealand context. These include alcohol-specific and tobacco-specific parenting, and ease of access to alcohol and tobacco, which were not included in the ASH Year 10 or Youth 2000 surveys and therefore could not be included in my doctoral research. However the Youth Insights Survey (a biennial survey of 14-15 year olds, run by the Health Promotion Agency as part of New Zealand's Youth Tobacco Monitor) includes questions on these topics, and since 2012, has also included questions on adolescent drinking and cannabis use as well as tobacco use. Thus there is an opportunity to extend my findings and approach to a more refined set of hypothesised contributors and to the more recent 2012-2018 period using Youth Insights Survey data.

In addition, the 2019 iteration of the Youth 2000 survey is currently in field in New Zealand, which will also provide opportunities to update and extend the research presented in my thesis. In particular, the Youth 2000 survey includes a number of questions about adolescents' lifetime and current exposure to violence and abuse. Thus there is an opportunity to explore whether declining exposure to violence and abuse has contributed to declines in a) risk behaviour as defined in the current study; and b) early, intense and/or multiple risk behaviours. Since engagement in early, intense and/or multiple risk behaviours is associated with greater risk of harm, the identification of factors that reduce such engagement could provide important insights for prevention efforts.

This relates to a more general recommendation for more research aimed at harm reduction and reducing disparities. Such research requires a clearer differentiation between predictors of risk behaviours (as defined in this thesis) and predictors of *harmful consequences* of risk behaviours (Grigsby et al. 2016). Although minor and low level engagement in risk behaviours *can* lead to addiction, injury and other harms (Chapter 2), such harms are not equally distributed among adolescent who engage in risk behaviours. For example, risk behaviour that is motivated by a desire to forget problems or cope with stress is more likely to lead to harm than risk behaviour motivated by desire for fun and sociability (Patrick et al. 2019). Due to their life circumstances, disadvantaged young people are more likely to engage in risk behaviour that is symptomatic of deeper problems, and more likely to suffer harm (Jessor 1991, Grigsby et al. 2016).

Therefore to address health disparities, we need not only a focus on reducing the prevalence of risk behaviours themselves (particularly in early adolescence, and particularly use of highly addictive substances like tobacco) but also an increased focus on the *contexts* (e.g. poverty,

sexual abuse, family violence, racism, psychosocial problems) that increase the likelihood of risk behaviour-related harm. A harm reduction approach requires a re-orientation of research, and a more nuanced conceptualisation of 'risk'.

Both in New Zealand and internationally there is a lack of public health research exploring the role that risk behaviours play in young people's lives, the social meanings ascribed to them, and how these may have changed over time. As discussed, it is plausible that the cultural position of risk behaviours has shifted, with major implications for adolescent behaviour. Emerging qualitative research provides a sense of what drinking means to young people today, and their stated reason for engaging or not engaging in alcohol use (Caluzzi 2019, Törrönen et al. 2019). Yet without a comparator, such research cannot draw robust conclusions about *change over time.* Qualitative research comparing contemporary with archival data (e.g. interviews or focus groups conducted in the 1990s) would provide opportunities to explore continuities and differences in the social meaning of substance use (and non-use) over time.

There is still descriptive work to be done, in particular further age-period-cohort analysis to determine in what countries, and in what behaviours, we are seeing a generational change (carried through to adulthood) versus a delay in onset of risk behaviours. This may differ in different countries and for different behaviours, and has important implications for theory and practice.

My study is one of the first to highlight the inter-relationships between risk behaviour trends. There is a need for more research that investigates how trends in smoking, drinking, drug use, sexual behaviour, and other risk behaviours are related. Testing whether the model I have developed (Fig 64) based on New Zealand findings is applicable to other countries could be a first step.

There is also an urgent need to understand whether the apparent decline in adolescent mental health is related to risk behaviour decline, or represents a separate trend with separate drivers. Before we celebrate the decline in adolescent risk behaviour as an unequivocal win, we must rule out the possibility that declining mental health represents the 'shadow side' of the same phenomenon.

International comparison studies may provide important insights about the drivers of risk behaviour decline at the country level. For example, such studies could identify the ways in which 'outlier' countries differ from those with declining adolescent risk behaviour in terms of

i) regulatory environment and enforcement; ii) culture, in particular drinking culture; and iii) trends in adolescent exposure to key predictors (e.g. parenting factors). This is a potentially fruitful avenue for research that has not yet been explored.

As previously discussed, the traditional tools of epidemiology are not well suited to addressing questions of why behaviour changes over time at the population level. The complexity of the systems in which adolescent risk behaviours are embedded presents a real challenge, particularly to quantitative research.

I have two suggestions for progressing public health research in the face of the challenge of complexity. The first is to consider what public health can learn from those disciplines with a longstanding focus on social and cultural changes and how these occur, for example sociology, cultural studies, history, and consumer psychology. What insights and tools from those disciplines could be applied to better understand the causes of the shift in adolescent behaviour that has occurred over the past 15-20 years? Interdisciplinary research that brings the strengths of different disciplines together, and triangulation of evidence from different disciplines may enable us to understand this phenomenon in a more holistic and nuanced way that incorporates complexity and reflexivity.

The second suggestion is to explore the use of quantitative techniques that have been developed to predict the behaviour of complex systems in disciplines such as physics, engineering and meteorology (Azar 2012). Although there has been growing interest in the application of systems science to public health in recent years, the application of techniques such as complex system dynamic modelling remains rare (Galea et al. 2009, Carey et al. 2015). As discussed above, such techniques may enable us to quantify the effect of peer feedback loops on adolescent behaviour over time, for example. More broadly, embracing complexity science may enable epidemiology and public health to move beyond linear cause and effect thinking, which has major limitations for explaining human behaviour. Since we are interested in the behaviour and wellbeing of populations, we must acknowledge the complexity of the real world in which such behaviour occurs, and our conceptualisations and methods must account for that complexity.

Implications for policy and practice

As discussed in Chapter 7, a delay in sexual debut and the uptake of substance use is likely to have positive implications for public health, since early engagement in these behaviours is

associated with greater risk of harm throughout the life course (Sawyer et al. 2012). If late-initiating cohorts continue their lower prevalence of smoking, binge drinking and cannabis use through to adulthood, the positive impacts could be profound (Hall et al. 2016). Either way, declining adolescent risk behaviour is good news for public health.

But although risk behaviours have declined substantially in adolescents since the turn of the 21st century, current levels of binge drinking, smoking, cannabis use, and unprotected sex among secondary school students remain high in New Zealand and in many other countries, particularly among disadvantaged young people. Therefore efforts to prevent these behaviours and reduce associated harms remain important. Such efforts should have a strong focus on decreasing ethnic, gender and socio-economic disparities.

The findings of this thesis suggest that adolescent attitudes and social norms are central to behaviour change in adolescents. Therefore continued efforts to denormalise risk behaviours (e.g. via social marketing campaigns aimed at young people) may yield further success, if such efforts are attuned to the values, tastes and concerns of the target population. International findings also suggest that parenting practices are influential, raising the possibility that efforts to change adolescent behaviour could target parents rather than (or as well as) young people themselves. This approach appears to have been successful in the Netherlands, for example, where a sharp decline in adolescent drinking was preceded by a prevention campaign urging parents to postpone alcohol use in their offspring until at least 16 years of age (de Looze et al. 2014).

Much public health research, policy and action is focused on specific conditions (e.g. cancer, heart disease, diabetes, HIV) or risk factors (e.g. smoking, alcohol use, unprotected sex) and the determinants of these. Such a narrow and disconnected approach tends to focus policy attention and intervention design on changing specific behaviours, one by one, rather than considering the adolescent as a whole person influenced by his or her context towards a certain 'way of being in the world' (Jessor, 1991).

My findings point to the importance of a more holistic approach. At the very least, public health researchers and policy makers across government need to acknowledge the fact that adolescent smoking, drinking and cannabis use influence one another and are likely to have secondary effects on other risk behaviours (e.g. unprotected sex, road safety, crime). Clearly, trends in one behavioural domain impact on the others. This has important policy implications. For example, policies that reduce adolescent binge drinking are also likely to

reduce smoking and cannabis use, and improve sexual health outcomes. Such policies should therefore be an adolescent health priority. To give another example, legalisation of cannabis, if it results in increasing prevalence or frequency of cannabis use, may lead to increased smoking and drinking in young people (Patton et al. 2005, Wang et al. 2018). Such knock on effects need to be weighed up alongside other costs and benefits in the policy analysis process.

Although the organisation of academic departments and governmental policy teams does not necessarily make it easy to work across these topic areas, a comprehensive and joined up approach to adolescent health and wellbeing is needed, and may lead to synergistic effects. Such a joined up approach should be strengths based (rather than deficit focused) and cognisant of the developmental needs of young people.

Importantly, we must be cognisant that a narrow public health focus on 'risk factors' and 'risk behaviours' without broader consideration of social context, developmental needs and overall wellbeing could end up being detrimental. We need to take a wide view and balance potential risks against potential benefits, remembering that health is a means to a good life, not an end in itself (Galea & Vaughan 2019). For example, injury prevention and personal safety concerns need to be balanced against children's and adolescents' developmental need for physical activity and independence. Child and youth mortality due to injury has fallen substantially since the turn of the century (Khan et al. 2018), but the wellbeing cost of protecting young people from injury in terms of reduced physical activity and independent mobility (and their consequences) may be substantial and yet to be fully felt.

Adolescent employment provides another example of the need to balance risks and benefits, with a view to wellbeing and healthy development. Part time employment in adolescence is a risk factor for substance use and sexual activity, but does that mean we should discourage adolescents from engaging in part time work? Evidence from the Dunedin study suggests employment at age 15 was associated with long-term benefits for that cohort (Iosua et al. 2014) and on balance the benefits are likely to outweigh the risks.

This does not mean that we should ignore or condone adolescent risk behaviours, since they do have real risks, and for a small proportion of young people, result in tragic – and preventable – consequences. But we must take a holistic view, and acknowledge that those at greatest risk of harm are young people facing structural oppression and/or difficult life circumstances (Jessor 1991, King et al. 2009). An increased focus on addressing underlying

problems such as poverty, parental addiction issues, and the historical and contemporary injustices of colonisation is necessary if we are to reduce the harms associated with adolescent risk behaviours. A narrow focus on adolescent behaviour rather than its context may result in victim-blaming and stigmatisation which only compounds the marginalisation of disadvantaged young people who smoke, take drugs or engage in other behaviours deemed to be 'risky'. We need a preventive approach that addresses the underlying issues that lead to (counterproductive) coping responses in adolescents, and views their overall wellbeing and development as the goal.

Conclusion

Since the turn of the 21st century there has been a major shift in adolescent behaviour characterised by substantial declines in smoking, drinking, illicit drug use and sexual activity. This shift has been observed in most (but not all) high-income countries and has occurred in both sexes, all main ethnic groups and all socio-economic groups.

There is no simple explanation for this unprecedented decline in adolescent risk behaviour. For example, evidence does not support the hypothesis that digital media use has displaced adolescent risk behaviour in terms of time use. Nor can preventive interventions take primary credit for the declines. Both behaviour-specific factors (e.g. less parental permissiveness towards adolescent drinking, changing adolescent attitudes towards smoking and drinking) and broad changes affecting multiple risk behaviours (e.g. less unsupervised time with friends) appear to be important contributors. It is likely that broad cross-national influences are *interacting* with behaviour-specific factors and the existing culture and context in each country to produce the pattern of trends that has been observed.

Declines in cannabis use and sexual activity appear to be largely secondary effects resulting from declining smoking and drinking, at least in New Zealand. Broader social changes such as increasing concern about health and safety, more involved and protective parenting and increasing competition for future job opportunities may have helped to create a milieu in which the more proximal factors have arisen or gained salience in young people's lives. It is also possible that social and technological changes have led to a shift in the social meaning of risk behaviours for young people. These are areas for future research.

There is much that is still unknown about the causes of declining risk behaviour, and about the forces that influence behaviour at the population level more generally. If we are to increase

our understanding, and harness that understanding for public health benefit, we must step up to the challenge of embracing the complexity of the real world in our research. This may require new interdisciplinary collaborations, new methods, and new ways of thinking, but the rewards are potentially transformational.

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APPENDIXES

Appendix A: ASH Year 10 sample characteristics

Sample characteristics and comparison with Year 10 population (% absolute difference)

		Total	Age		Sex		School Decile			Ethnicity			
			14 years	15 years	Male	Female	Low	Medium	High	NZEO	Maori	Pacific	Asian
2003	N	31377	14585	16792	15492	15885	5272	14274	11831	20716	5425	2174	3062
	%		46%	54%	49%	51%	17%	45%	38%	66%	17%	7%	10%
	dif from pop				-2%	2%	-3%	3%	5%				
2006	N	31690	19996	11694	15642	16048	4416	15935	11339	20161	6237	2252	3040
	%		63%	37%	49%	51%	14%	50%	36%	64%	20%	7%	10%
	dif from pop				-2%	2%	-4%	4%	4%	2%	-2%	-1%	1%
2007	N	25109	16213	8896	11988	13121	3558	11062	10489	16187	4653	1804	2465
	%		65%	35%	48%	52%	14%	44%	42%	64%	19%	7%	10%
	dif from pop				-4%	4%	-4%	-2%	10%	5%	-3%	-2%	0%
2008	N	29682	18395	11287	14462	15220	4732	12875	12075	17913	5552	2863	3354
	%		62%	38%	49%	51%	16%	43%	41%	60%	19%	10%	11%
	dif from pop				-3%	3%	-2%	0%	3%	1%	-3%	1%	1%
2009	N	24755	15977	8778	11607	13148	3235	11029	10491	15410	4304	2211	2830
	%		65%	35%	47%	53%	13%	45%	42%	62%	17%	9%	11%
	dif from pop				-4%	4%	-5%	1%	4%	4%	-5%	0%	2%
2010	N	31696	19725	11971	16636	15060	5111	14049	12536	18806	6315	3041	3534
	%		62%	38%	52%	48%	16%	44%	40%	59%	20%	10%	11%
	dif from pop				1%	-1%	-2%	1%	2%	2%	-3%	0%	1%

			Age		Sex		School Decile			Ethnicity			
		Total	14 years	15 years	Male	Female	Low	Medium	High	NZEO	Maori	Pacific	Asian
2011	N	26028	21390	4638	12462	13566	3720	10843	11465	15669	4995	2453	2911
	%		82%	18%	48%	52%	14%	42%	44%	60%	19%	9%	11%
	dif from pop				*-3%*	*3%*	*-4%*	*-1%*	*6%*	*3%*	*-4%*	*0%*	*0%*
2012	N	30396	25098	5298	14918	15478	4982	12461	12953	17878	5800	3048	3670
	%		83%	17%	49%	51%	16%	41%	43%	59%	19%	10%	12%
	dif from pop				*-2%*	*2%*	*-1%*	*-2%*	*4%*	*4%*	*-3%*	*1%*	*1%*
2013	N	27014	22126	4888	13546	13468	4049	10875	12090	16146	5111	2628	3129
	%		82%	18%	50%	50%	15%	40%	45%	60%	19%	10%	12%
	dif from pop				*-1%*	*1%*	*-3%*	*-2%*	*5%*	*3%*	*-4%*	*0%*	*1%*
2014	N	29303	24206	5097	14164	15139	4359	12836	12108	16847	5779	2952	3725
	%		83%	17%	48%	52%	15%	44%	41%	57%	20%	10%	13%
	dif from pop				*-3%*	*3%*	*-3%*	*2%*	*2%*	*2%*	*-4%*	*1%*	*1%*
2015	N	20443	16630	3813	10155	10288	3540	10024	6879	12123	4215	1884	2221
	%		81%	19%	50%	50%	17%	49%	34%	59%	21%	9%	11%
	dif from pop				*-2%*	*2%*	*-2%*	*5%*	*-2%*	*4%*	*-3%*	*0%*	*-1%*

Notes: Population data is based on Ministry of Education (MoE) records available online at: https://www.educationcounts.govt.nz/statistics/schooling/student-numbers/6028. Ethnicity data is not available from MoE prior to 2006, so ethnic comparison of population and sample is not possible for 2003.

Appendix B: Sensitivity analyses for Youth 2000 analyses

Missing data, and -- more importantly -- change over time in the proportion missing, are problems for all of my Youth 2000 outcome variables: past month tobacco use, past month cannabis use, past month binge drinking, and sexual activity. Counts of valid and missing responses, based on raw (unweighted) data, are provided in Table 61.

Table 61: Counts of missing and valid responses for risk behaviour outcome variables, 2001-2012.

		2001	2007	2012
Past month smoking	Missing	611	555	201
	Yes	1011	448	242
	No	4891	4931	5046
Past month cannabis use	Missing	869	862	266
	Yes	976	491	308
	No	4668	4581	4915
Past month binge drinking	Missing	786	601	225
	Yes	1850	1393	712
	No	3877	3940	4552
Sexually active	Missing	471	923	180
	Yes	979	992	590
	No	5063	4019	4719

The main analysis presented in the body of my thesis is based on valid responses only (i.e. individuals with missing data are excluded from the analysis). Analysis of item non-response shows that those who did not answer questions about risk behaviours systematically differed from responders, e.g. ethnic minorities and students from low-decile schools were over-represented among those who did not answer the questions on risk behaviours. It is likely that item non-response is influenced by the sensitive nature of the questions, i.e. some non-responders may be motivated by a wish to conceal behaviour that is against the rules. Therefore my main analysis is almost certainly biased by item non-response to some extent.

It is notable that the proportion missing in the most recent survey year (2012) is considerably lower than in 2001 and 2007 for all four outcome variables. This is largely because the 'I do not want to answer' option was removed in 2012, but the proportion who skipped the question entirely also decreased between 2007 and 2012.

If we assume that non-responders are more likely to engage in risk behaviour than responders (a reasonable assumption given their demographic profile, and possible desire to hide their rule-breaking behaviour), this has the effect of 'flattening' the trend, since the 2001 and 2007 values are likely to be underestimated relative to the 2012 values. In other words, the pattern of 'missingness' across survey years produces a conservative bias in risk behaviour trends.

Because respondents' risk behaviour engagement is likely to influence whether or not they answer these questions, item non-response is not 'missing at random' or 'missing completely at random', and therefore use of imputation to address the problem of missing data is not appropriate (Bennett 2001). Instead, I have undertaken sensitivity analyses to test whether my conclusions hold under various assumptions.

Are observed declines in risk behaviours robust to varying assumptions about missing data?

Prevalence of risk behaviours

To define the parameters within which the actual 2001-2012 trend for the outcome variables lies, I plotted Case 1 which excludes missing data (i.e. the main analysis present in my thesis), then added both extreme case scenarios: that *all* non-responders were abstinent (Case 2), and that *all* non-responders were past month users /sexually active (Case 3). The results are shown in Figures 65-68 below.

They show that - although population estimates vary greatly under these different scenarios - even under extreme assumptions, the conclusions of the main analysis hold, i.e. there was a decline in smoking, cannabis use and binge drinking over the study period as a whole, and in both halves of the study period. Under all cases, sexual activity fell across the study period as a whole, but rose between 2001 and 2007 before falling between 2007 and 2012. Therefore, my confidence in these conclusions is strong.

Assuming that non-responders are more likely to engage in risk behaviours than responders (which, as explained above is a reasonable assumption), the 'true' prevalence will lie between Case 1 and Case 3.

Figure 65: Prevalence of past month tobacco use in 13-15 year olds, using varying assumptions about missing data

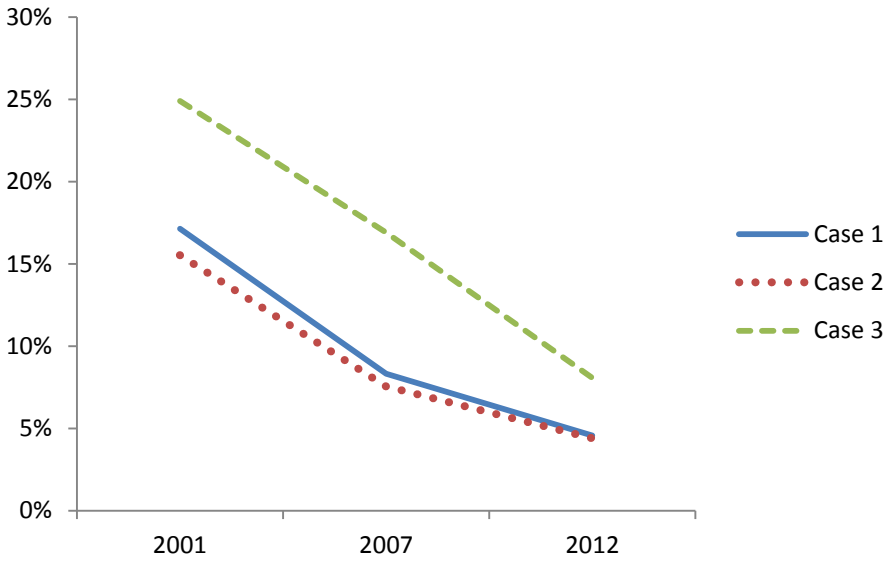


Figure 66: Prevalence of past month cannabis use in 13-16 year olds, using varying assumptions about missing data.

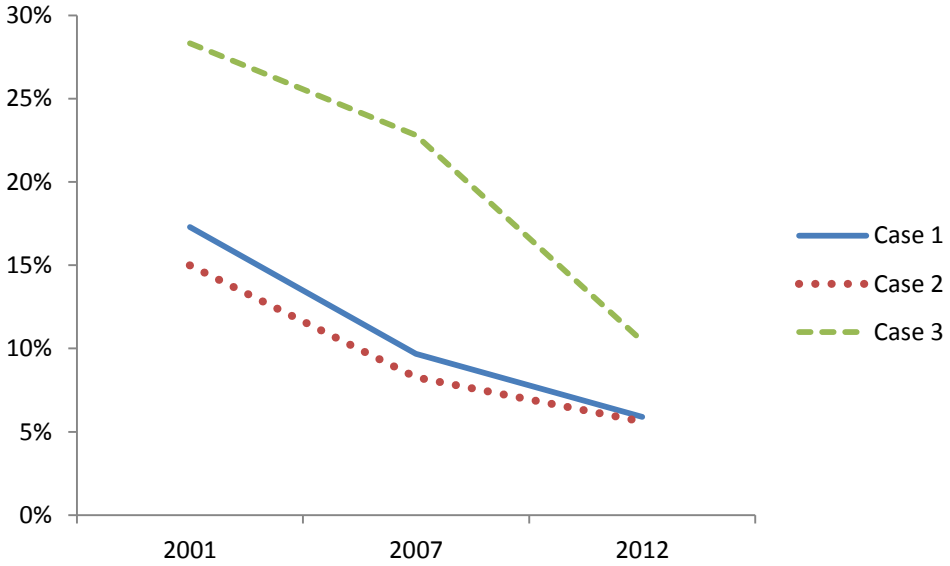


Figure 67: Prevalence of past month binge drinking in <16 year olds, using varying assumptions about missing data

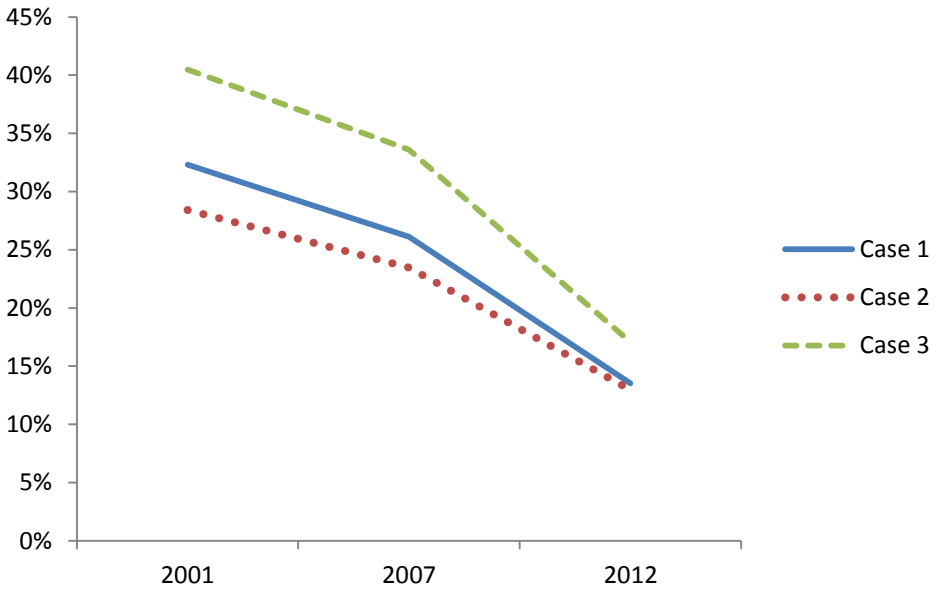
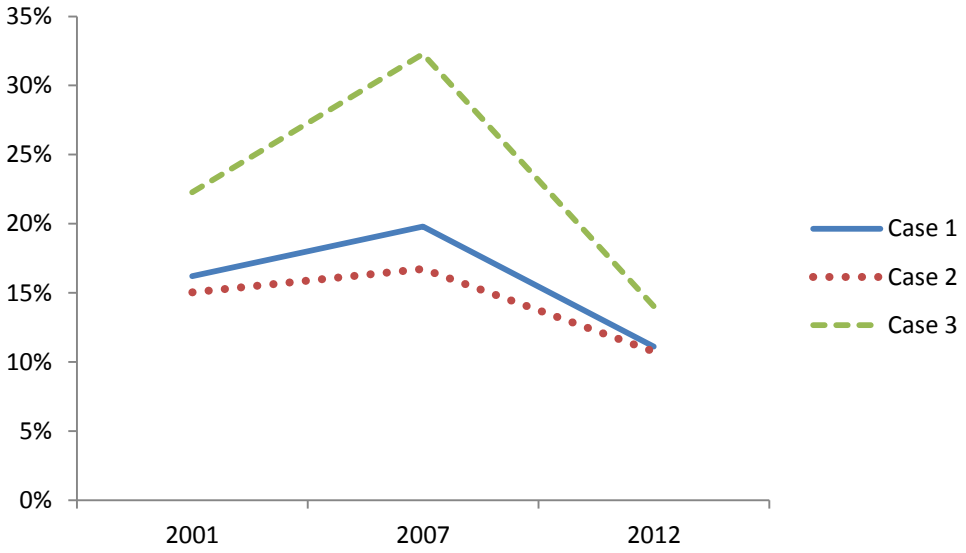


Figure 68: Prevalence of sexual activity (past 3 months) in <16 year olds, using varying assumptions about missing data.



Number of risk behaviours reported

The same approach was taken to define the parameters within which the 'true' estimate for number of risk behaviours lies. The main analysis was restricted to individuals with available data for all four risk behaviour outcomes. This excluded 16% of respondents in 2001, 22% in 2007 and 6% in 2012. Such a large proportion of missing data, and in particular the uneven missingness across years, has almost certainly biased the results to some extent.

Again, I plotted Case 1, based on complete case analysis, as presented in the main analysis in the body of the thesis. I then added the extreme case scenarios: that *all* non-responders were abstinent (Case 2) and that *all* non-responders were past month users /sexually active (Case 3). The results are shown in Figures 69-73 below.

Figure 69: Proportion (%) reporting no risk behaviours by year, using varying assumptions about missing data

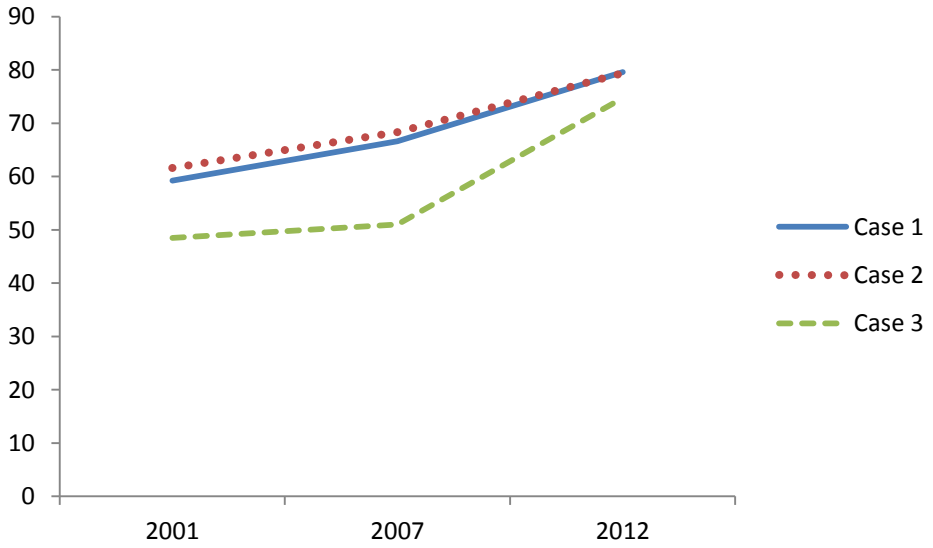


Figure 70: Proportion (%) reporting one risk behaviour by year, using varying assumptions about missing data

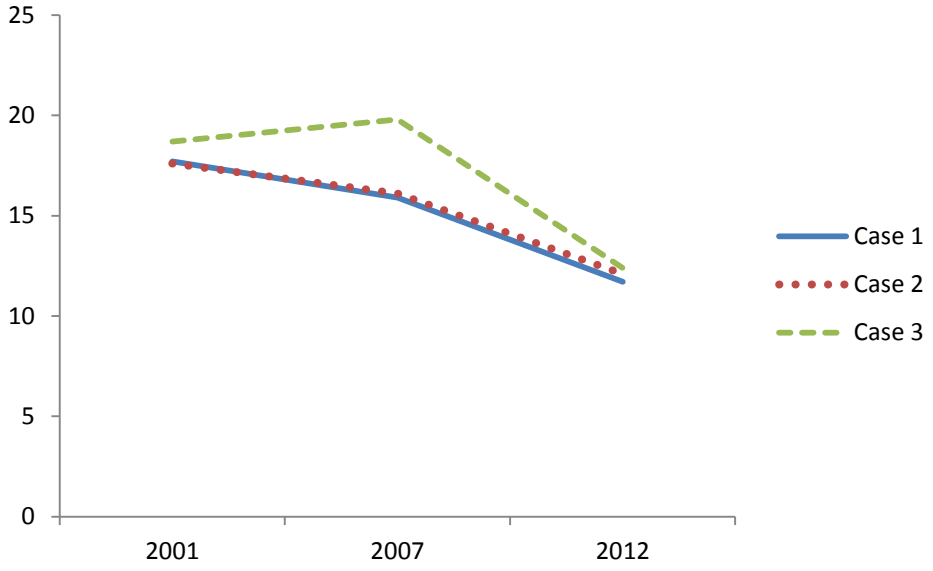


Figure 71: Proportion (%) reporting two risk behaviours by year, using varying assumptions about missing data

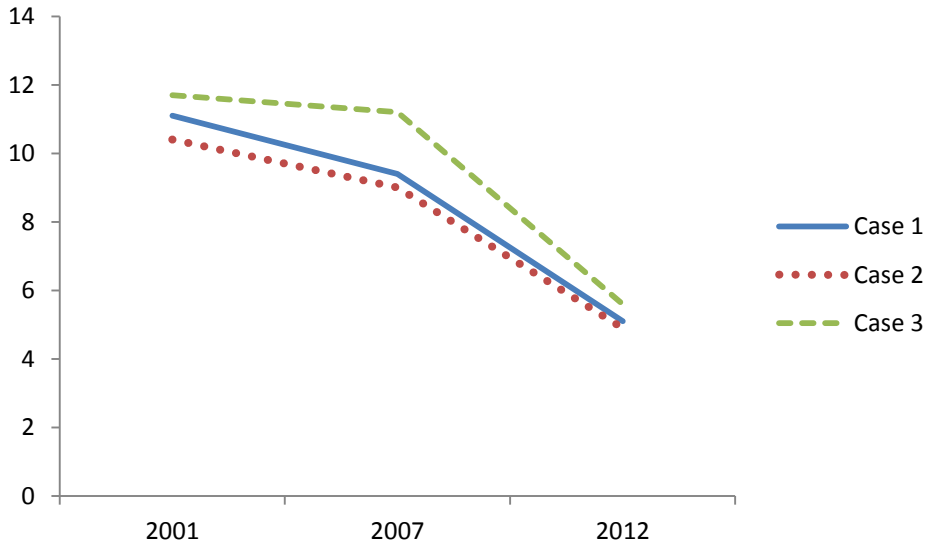


Figure 72: Proportion (%) reporting three risk behaviours by year using varying assumptions about missing data

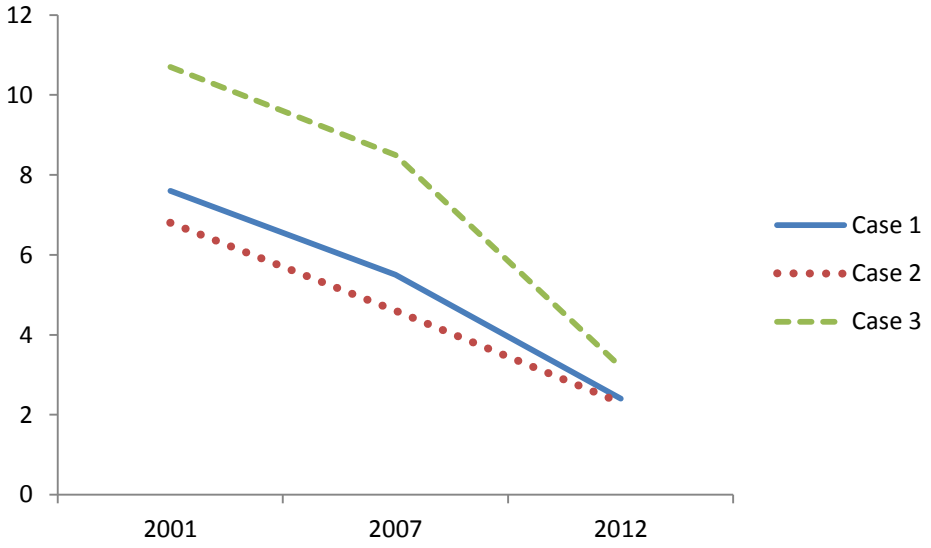
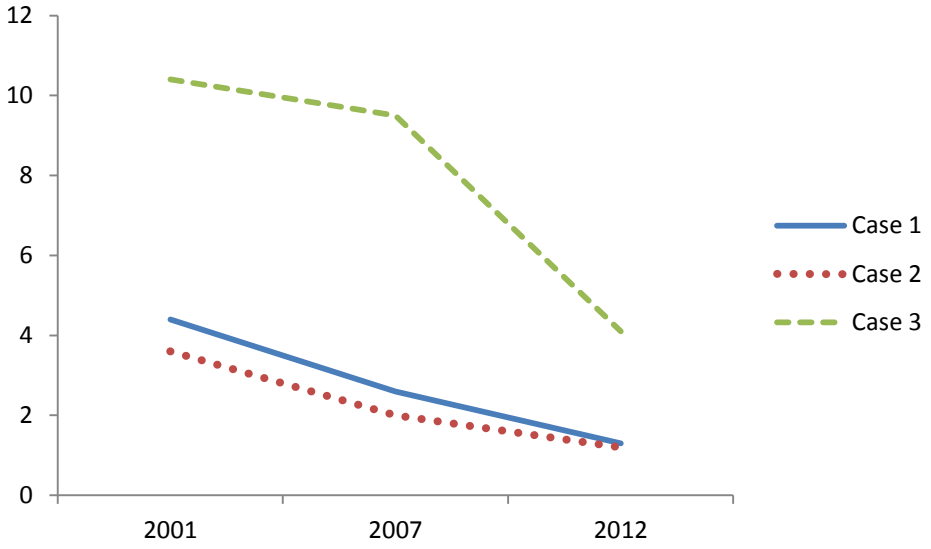


Figure 73: Proportion (%) reporting all four risk behaviours by year, using varying assumptions about missing data



Again, the 'true' value almost certainly lies between Case 1 and Case 3, assuming that non-responders are more likely to engage in risk behaviours than responders. The results show that even under extreme (unrealistic) assumptions about non-responders, we see an increase over the study period in the proportion reporting no risk behaviours, and a decrease in the

proportion reporting 1, 2, 3 or 4 risk behaviours. Despite considerable uncertainty about the 'true' population estimates, we can be confident that these conclusions are robust.

Are findings about the contributors to risk behaviour trends robust to varying assumptions about missing data?

A similar approach was taken to exploring the robustness of trend analyses. Each of the outcome variables was recoded based on the 'extreme' assumptions above, for example for tobacco trend analysis all non-responders were recoded as non-smokers under Case 2, and all non-responders were recoded as past month smokers under Case 3. The results for tobacco trends are shown in Table 2.

Table 62: Sensitivity analysis for adolescent tobacco smoking trends, 2001-2012

	Case 1 (main analysis)	**Case 2**	**Case 3**
Base model OR for 2012(ref 2001) adjusted for demographic factors	0.20	0.21	0.23
Potential explanatory variables			
Parental monitoring	0.21	0.23	0.25
Fun with family	0.19	0.21	0.23
Family relationship	0.21	0.23	0.25
Maternal closeness	0.20	0.21	0.23
Paternal closeness	0.19	0.21	0.23
Maternal warmth	0.19	0.21	0.23
Paternal warmth	0.19	0.21	0.23
Students treated fairly	0.22	0.22	0.25
Sense of belonging at school	0.21	0.21	0.24
School expects me to do well	0.20	0.20	0.23
Intention to complete school	0.23	0.23	0.25
Plans after leaving school	0.19	0.19	0.22
Part time job	0.21	0.22	0.18
Contributing home, school and work factors combined	0.25*	0.27*	0.22
Attitudes: OK to smoke regularly	0.45*	0.46*	0.37*

	Case 1 (main analysis)	Case 2	Case 3
Attitudes: OK to drink regularly	0.28*	0.28*	0.26
Attitudes: OK to use cannabis regularly	0.22	0.23	0.22
Parental smoking	0.21	0.21	0.20
Parental drinking	0.21	0.21	0.20
Parental cannabis use	0.19	0.19	0.18
Past month cannabis use	0.25	0.26	0.26
Past month binge drinking	0.29*	0.30*	0.29
Sexually active	0.19	0.20	0.19

All analyses are adjusted for demographic factors: age, sex, ethnicity and school decile.

**p<0.05 statistically significant difference in OR from base model*

The results show Case 2 (none of the non-responders smoked in the past month) is very similar to the main analysis (Case 1) in terms of values, patterns and statistically significant findings (Table 2). Case 3 (all of the non-responders smoked in the past month) also has broadly similar results, but an important difference is that the finding that contributing home, school and work factors (in combination) make a small but statistically significant contribution to the trend does not hold under Case 3. Also, past month binge drinking does not quite reach statistical significance under Case 3. Another difference is that 'part time job', 'parental smoking' and 'parental drinking' seem to be putting *upward* rather than downward pressure on smoking under Case 3, but the magnitude of the effect is small (not statistically significant) and these are not important factors for explaining adolescent smoking decline under any scenario.

The sensitivity analysis shows that, regardless of assumptions about non-responders, most of the key conclusions hold: attitude to tobacco use is the biggest contributor under all scenarios; attitudes to alcohol along with past month binge drinking and cannabis use are also important; none of the home or school factors, individually, makes a statistically significant contribution. However the conclusion that, in combination, home, school and work factors make a significant contribution to the trend does *not* hold under Case 3.

Table 3 shows the results of sensitivity analysis for cannabis trends. Again, there is a similar pattern of results under Case 1 and Case 2: attitude to smoking is the strongest contributor, followed by past month binge drinking and smoking, and then attitudes to alcohol. In both

cases, these were the factors that statistically significantly attenuated the trend, when added to the base model.

Table 63: Sensitivity analysis for adolescent cannabis use trends, 2001-2012

	Case 1 (main analysis)	Case 2	Case 3
Base model OR for year(ref2001) adjusted for demographic factors	0.32	0.36	0.30
Potential explanatory variables			
Parental monitoring	0.34	0.39	0.32
Fun with family	0.31	0.35	0.30
Family relationship	0.34	0.39	0.32
Maternal closeness	0.32	0.36	0.30
Paternal closeness	0.31	0.35	0.29
Maternal warmth	0.30	0.35	0.29
Paternal warmth	0.31	0.35	0.29
Students treated fairly	0.35	0.39	0.32
Sense of belonging at school	0.33	0.38	0.31
School expects me to do well	0.33	0.37	0.30
Intention to complete school	0.37	0.42	0.33
Plans after leaving school	0.31	0.35	0.28
Part time job	0.34	0.37	0.26
Contributing home, school and work factors combined	0.43*	0.47*	0.31
Attitudes: OK to smoke regularly	0.61*	0.64*	0.42*
Attitudes: OK to drink regularly	0.47*	0.50*	0.36
Attitudes: OK to use cannabis regularly	0.38	0.41	0.31
Parental smoking	0.33	0.36	0.28
Parental drinking	0.34	0.36	0.28
Parental cannabis use	0.29	0.31	0.25
Past month tobacco smoking	0.51*	0.53*	0.42*
Past month binge drinking	0.52*	0.54*	0.42*
Sexually active	0.32	0.36	0.26

All analyses are adjusted for demographic factors: age, sex, ethnicity and school decile.
**p<0.05 statistically significant difference in OR from base model*

Under Case 3, attitudes to alcohol use didn't reach statistical significance, and the other three significant factors all attenuated the trend to the same extent. As for smoking trends, the effects of parental smoking and alcohol use, and part time job were in the opposite direction under Case 3 than under Case 1 and 2, but as noted above these were not important variables under any scenario. In short, the key conclusions of the cannabis trend analysis hold under all assumptions about non-responders.

Table 64: Sensitivity analysis for adolescent binge drinking trends, 2001-2012

	Case 1 (main analysis)	**Case 2**	**Case 3**
Base model OR for year (ref 2001) adjusted for demographic factors	0.33	0.37	0.30
Potential explanatory variables			
Parental monitoring	0.35	0.40	0.32
Fun with family	0.32	0.36	0.30
Family relationship	0.34	0.40	0.32
Maternal closeness	0.33	0.38	0.30
Paternal closeness	0.32	0.37	0.29
Maternal warmth	0.32	0.37	0.29
Paternal warmth	0.32	0.37	0.29
Students treated fairly	0.36	0.41	0.32
Sense of belonging at school	0.34	0.39	0.31
School expects me to do well	0.33	0.38	0.30
Intention to complete school	0.36	0.41	0.32
Plans after leaving school	0.32	0.37	0.29
Part time job	0.35	0.39	0.29
Contributing home, school and work factors combined	0.41*	0.46*	0.34
Attitudes: OK to smoke regularly	0.52*	0.56*	0.45*
Attitudes: OK to drink regularly	0.50*	0.54*	0.43*
Attitudes: OK to use cannabis regularly	0.36	0.39	0.32
Parental smoking	0.34	0.37	0.31
Parental drinking	0.36	0.39	0.32
Parental cannabis use	0.31	0.34	0.28

	Case 1 (main analysis)	Case 2	Case 3
Past month smoking	0.42*	0.45*	0.42*
Past month cannabis use	0.38	0.41	0.38*
Sexually active	0.31	0.36	0.31

All analyses are adjusted for demographic factors: age, sex, ethnicity and school decile.
**p<0.05 Statistically significant difference in OR from base model*

Table 4 shows the results of sensitivity analyses for the binge drinking trend. Again the results under Case 2 and Case 3 are very similar to those for the main analysis (Case 1). In all cases, attitudes to smoking and drinking attenuated the trend to the greatest extent, followed by past month smoking and past month cannabis use. The first three were statistically significant in all three cases, whereas past month cannabis use only reached statistical significance under Case 3. 'Part time job' was the only variable for which the direction of effect was differed depending on assumptions about non-responders. However, as noted previously, the magnitude of effect was not statistically significant in either direction, and this variable was not an important determinant of the trend. Therefore we can be confident that conclusions about the main contributors to the trend in binge drinking are robust to possible bias caused by missing data.

Table 65: Sensitivity analysis for adolescent sexual activity trends, 2001-2012

	Case 1 (main analysis)	Case 2	Case 3
Base model OR for year (ref 2001) adjusted for demographic factors	0.68	0.72	0.60
Potential explanatory variables			
Parental monitoring	0.74	0.78	0.63
Fun with family	0.67	0.71	0.61
Family relationship	0.74	0.77	0.64
Maternal closeness	0.69	0.73	0.61
Paternal closeness	0.67	0.71	0.60
Maternal warmth	0.66	0.70	0.59
Paternal warmth	0.67	0.70	0.59
Students treated fairly	0.77	0.81	0.66
Sense of belonging at school	0.72	0.77	0.63
School expects me to do well	0.70	0.74	0.61
Intention to complete	0.78	0.81	0.66

	Case 1 (main analysis)	Case 2	Case 3
school			
Plans after leaving school	0.66	0.71	0.58
Part time job	0.76	0.80	0.59
Home, school and work factors combined	0.98*	1.02*	0.73*
Attitudes: OK to smoke regularly	1.19*	1.23*	0.90*
Attitudes: OK to drink regularly	0.97*	1.02*	0.77*
Attitudes: OK to use cannabis regularly	0.84*	0.88*	0.70
Parental smoking	0.73	0.76	0.63
Parental drinking	0.72	0.76	0.61
Parental cannabis use	0.67	0.70	0.63
Past month tobacco use	1.03*	1.06*	0.83*
Past month binge drinking	1.12*	1.15*	0.88*
Past month cannabis use	0.98*	1.02*	0.82*

All analyses are adjusted for demographic factors: age, sex, ethnicity and school decile.
**p<0.05 Statistically significant difference in OR from base model*

Table 5 shows the results of sensitivity analysis for the sexual activity trend. Under all three Cases attitude to substance use and past month substance use variables attenuated the trend to the greatest extent. Attitude to cannabis use did not reach statistical significance under Case 3, but otherwise the statistically significant variables were the same under each scenario. As for the other outcomes, the direction of effect for 'part time job' was different for Case 3 than for Case 1 or 2, but in other respects the pattern of results was very similar regardless of assumptions about missing data.

Conclusion

Missing data for the four outcomes of interest – smoking, cannabis use, binge drinking and sexual activity – were a potential source of bias, which could not be addressed using imputation. The results of my sensitivity analyses illustrate the parameters of the possible effect of this missing data. They show that, although there is considerable uncertainty about population estimates, conclusions about *trends over time* are robust to even extreme assumptions about item non-responders. If anything, trends are likely to be *underestimated* in the main analysis. The results in relation to analysis of the contributors to the trends show that almost all the conclusions of the main analysis hold under all assumptions about missing

data. However the direction of effect for parental alcohol and tobacco use and part time job differed according to assumptions about missing data, and therefore any conclusions relating to these variables should be treated with caution. In summary, the data is far from perfect, but in general my findings are robust to any bias due to item non-response.