Second-Hand Smoke: The Evolution of Children's Exposure

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SECOND-HAND SMOKE: THE EVOLUTION OF CHILDREN'S EXPOSURE

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ABSTRACT

Second-hand smoke exposure (SHSe) causes significant morbidity and mortality in children. A large proportion of children with smoking parents do not live in smoke-free homes, however, to date, little is known about the prevalence of partial smoking restrictions and their efficacy in reducing children's SHSe. Given the lack of convincing evidence on how to achieve further reductions in children's SHSe in the home, the identification of the modifiable factors associated with childhood SHSe is imperative to reduce the burden of disease resulting from childhood SHSe. Analysis of the Omnibus Survey (OS) revealed that the prevalence of smoke-free homes in England did not increase significantly between 2006 and 2008. Only 30% of smokers reported a smoke-free home in 2008. However, during the same time period, the proportion of smokers (who did not have a smoke-free home) reporting that they did not smoke when in the same room as a child increased significantly from 62.5% to 74.8%. Using the Health Survey for England, biologically validated self-reported measures of child SHSe revealed that in 2008 and 2009 approximately 50% of children living with a smoking parent were not exposed to SHSe in the home (0.30ng/ml, 95% confidence interval 0.27-0.32ng/ml). Of the 50% of children who remained exposed inside the home, 29% had a parent that smoked in one room only in the home. These children had significantly lower cotinine concentrations (1.13ng/ml, 95% CI 1.05-1.22) than the 21% of children with smoking parents who smoked in 2 or more rooms in the home (2.36ng/ml, 95% CI 2.08-2.68ng/ml). Although smoking in one room equates to lower risk it does not equate to no risk and so interventions are required to change indoor smoking to outdoor smoking. The OS data found that good knowledge of SHS-related illnesses was predictive of both full and partial smoking restrictions in the home. Increases in the proportion of respondents with good knowledge occurred during 2003-2006, a period when frequent anti-SHS mass media campaigns were aired. A case-study evaluation of a brief mass media campaign in the North West and North East of England, which aimed to move smoking parents to smoke outside, was found to have no statistically significant effect on home smoking behaviour in the short term, however knowledge that SHS caused both heart attack and Sudden Infant Death Syndrome increased in this region following the campaign whilst simultaneous decreases were found in the rest of England. Following the identification of those children most exposed to SHS, and the modifiable factors associated with this exposure, this thesis suggests that a comprehensive multi-level approach to tobacco control policy, which includes emotive media campaigns which include information on SHS-related illnesses, will contribute to the continued reduction of childhood SHSe.

PUBLICATIONS & CONFERENCE PROCEEDINGS

Publications

Evans, K. A., Sims, M., Judge, K. & Gilmore, A. (2012). Assessing the knowledge of the potential harm to others caused by second-hand smoke and its impact on protective behaviours at home. *Journal of Public Health,* 34(2), 183-194.

Conference proceedings

Evans, K. A. (2010) Trends and determinants of people's knowledge of the illnesses caused by second-hand smoke (SHS), and the relationship between knowledge and SHS related behaviours. *Proceedings of the 2010 conference of the Society for Research on Nicotine and Tobacco,* Bath, September 2010

Evans, K.A., Gilmore, A. Sims, M. Judge, K. F. (2011) Does good knowledge of the illnesses caused by second-hand smoke (SHS) influence SHS-protective behaviours? *Proceedings of the 2011 European Conference on Tobacco or Health.*

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ABBREVIATIONS

ASH	Action on Smoking and Health
CTCP	California Tobacco Control Program
DH	Department of Health
FCTC	Framework Convention on Tobacco Control
HPA	Health Promotion Agency (Northern Ireland)
HSE	Health Survey for England
IARC	International Agency for Research on Cancer
NW/NE	North West and North East of England
OS	Omnibus Survey
RCP	Royal College of Physicians
RCT	Randomised Control Trial
SCOTH	Scientific Committee on Tobacco and Health
SEP	Socio-economic position
SES	Socioeconomic status
SFL	Smoke-free Legislation
SHS	Second-hand smoke
SHSe	Second-hand smoke exposure
SIDS	Sudden Infant Death Syndrome
USDHHS	United States Department for Health and Health Sciences
WHO	World Health Organisation

CHAPTER 1. INTRODUCTION

1.1 General overview of thesis

Smoking is the leading cause of death globally, with an estimated 6 million deaths worldwide in 2011 with approximately 600 000 of these deaths attributable to second-hand smoke exposure (SHSe) (Eriksen, Mackay, & Ross, 2012). According to the most recent economic impact assessment, smoking-related illness cost the NHS £2.7 billion in 2006/7 (Callum, Boyle, & Sanford, 2010). However, the costs of the significant morbidity that non-smokers experience as a result of exposure to the tobacco smoke of others are not included in these financial estimates. The total costs of childhood disease caused by SHS have been estimated at £23.3 million per annum in the UK (RCP, 2010).

Since the 1950s when the ill-effects of tobacco were first widely discussed in the UK, tobacco control advocates have campaigned for increased regulation of the tobacco industry and for the implementation of initiatives that would help lead to the denormalisation and reduction of smoking. Despite the committed efforts of public health groups such as the Royal College of Physicians (RCP) and tobacco control organisations like Action and Smoking in Health (ASH), it was not until after the publication of the New Labour White paper *Smoking Kills* in England in 1998, that tobacco control became a constant presence on the public health policy agenda, with a number of policies implemented in the last decade. Notable amongst these was the 2007 smoke-free legislation (SFL), the first piece of tobacco control legislation in England specifically aimed at protecting non-smokers from the ill-effects of second-hand smoke (SHS) in public places and workplaces.

Consequent to this legislation children's SHSe occurs mainly in the home (RCP, 2010). Children living with smoking parents are particularly at risk, as they have less power to limit their exposure and their physiology (e.g. higher respiratory rates compared to adults) leads to a greater intake of toxins (Willers, Skarping, Dalene, & Sekerfving, 1995). There are proven links between SHS and significant morbidity in children (RCP, 2010) and in relation to some conditions, mortality. The health impacts of SHSe on children's health will be discussed in more detail later in this chapter. Furthermore, children with a least one smoking parent, had a 72% (OR 1.72 95% CI 1.59-1.86) increased risk of taking up smoking themselves compared to those children with non-smoking parents. Similarly, living in a

home where smoking occurred indoors increased the risk of the child taking up smoking by 92% (OR 1.92 95% CI 1.70-2.16) (RCP, 2010). It is thought that observing parental smoking and smoking in the home, normalises smoking behaviour, thereby making it a more acceptable future option (Goddard, 1992; Hudson & Thomson, 2011; Loureiro, Sanz-de-Galdeano, & Vuri, 2010).

While SFL could increase the prevalence of smoking in the home and thus children's exposure, it could, like other tobacco control policies, lead to reductions in exposure via changes in home smoking behaviours. Such changes occur as a result of modifications in individuals' knowledge and attitudes as well as group social norms. Changes in complex behaviours do not occur over-night, there are a number of factors that combine to maintain particular health behaviours and therefore change often occurs in stages as these factors themselves change. Getting smokers to stop smoking in indoor public places and workplaces was not complex as the law and society helped enforce these changes. However, according to the ecological approach to behaviour change, changing engrained behaviour, like smoking in the private domain of individuals' homes is complex and requires pre-requisite changes in individual, interpersonal and environmental factors. Motivating individuals to prohibit smoking in their homes was not an express aim of the SFL and it may be the case that the impacts of national policy interventions on home smoking policies are not clear for many years (Glanz & Bishop, 2010; Siegel & Lotenberg, 2007). However, whilst changes in home smoking behaviour post-SFL might not be immediately apparent, there are important process markers of public health policy interventions such as changes in individuals' knowledge of the dangers of SHS and attitudes towards SHSe and the restrictions imposed by the SFL. These measures can be used as interim measures of policy impact which may hint at future change in home smoking policy (Siegel & Lotenberg, 2007).

In light of the considerable health impacts of SHSe in children, the fact that most SHSe now occurs in the home with 79% of children with two smoking parents and 63% of children with one smoking parent exposed in the home in 2007, a greater understanding of parental knowledge and behaviour in relation to SHS and children's exposure to SHS are important prerequisites to developing public health policy interventions (Jarvis, Mindell, Gilmore, Feyerabend, & West, 2009). Green et al (2003) eloquently captured the essence of what this thesis is trying to achieve in the following statement:

> *"There is a need to develop approaches that galvanise support for making non-smoking a social norm in the home. These approaches will depend on the identification of target groups for intervention and on the identification of acceptable strategies for reducing environmental tobacco smoke levels in the domestic setting."* (Green, Courage & Rushton, 2003, p47)

This thesis is about children's SHSe in the home; the proportion exposed in the home, the extent of this exposure and the determinants of children's exposure, particularly the modifiable determinants. The identification of those still at risk is essential in order to direct future interventions to reduce their exposure and protect their health.

First, the thesis explores the prevalence of smoke-free homes in England post-legislation and measures the prevalence of partial restrictions that parents employ in an effort to decrease levels of SHS in the home. The efficacy of restricting home smoking to certain rooms is explored by measuring children's cotinine concentrations. Furthermore, the multilevel determinants of child exposure are explored whereby the relationship between children's individual, household and area level characteristics and their SHSe are investigated in order to steer and pitch future smoking-related interventions at the most appropriate level. A case study of a mass media campaign that aimed to change parent's smoking behaviour in the home is reviewed. The thesis highlights the need for continued action and counters the view of some that tobacco control is 'done'.

1.2 Tobacco and tobacco control

1.2.1 Evolution of tobacco use

Before cigarettes were mass produced, most tobacco use was in the form of nasal snuff, chewing tobacco, pipes and cigars and smoking was a habit of the upper classes. The invention of the paper-rolled cigarette in 1831 was a significant development (Goodman, 2005). Cigarettes were considered easier to use, cleaner and increasingly affordable. In the 1880s the invention of the Bonsack cigarette making machine led to the mass production of cigarettes which made tobacco even more affordable and widely available. This mass production was a powerful mechanism in the rapid increase of smoking prevalence in economically developed countries, which contributed to the evolution of stage 1 of what we now refer to as 'the smoking epidemic' (Figure 1). Stage 1 of the smoking epidemic in Britain occurred in the early years of the twentieth century and was characterised by a

significant increase in the proportion of young men smoking (Doll, Peto, Wheatley, Gray, & Sutherland, 1994; Peto & Lopez, 2001; Thun, Peto, Boreham, & Lopez, 2012). In stage 2, smoking increased relentlessly amongst men and, following the First World War, this pattern was mirrored by women (albeit to a lesser magnitude) with an increasing number taking up smoking. Smoking was popular, socially acceptable, the health effects were not yet in the public domain and tobacco control was not on the agenda. The tobacco industry became a global enterprise looking to capitalize on profits. Following the Second World War, male and particularly female, prevalence increased further still. In 1950 over half of all UK men smoked. It was at this time that the link between lung cancer and smoking started to emerge in the British media (Doll & Hill, 1950). Stage 3, post-1960, was characterised by the first declines in smoking prevalence in males and females since the start of the epidemic.

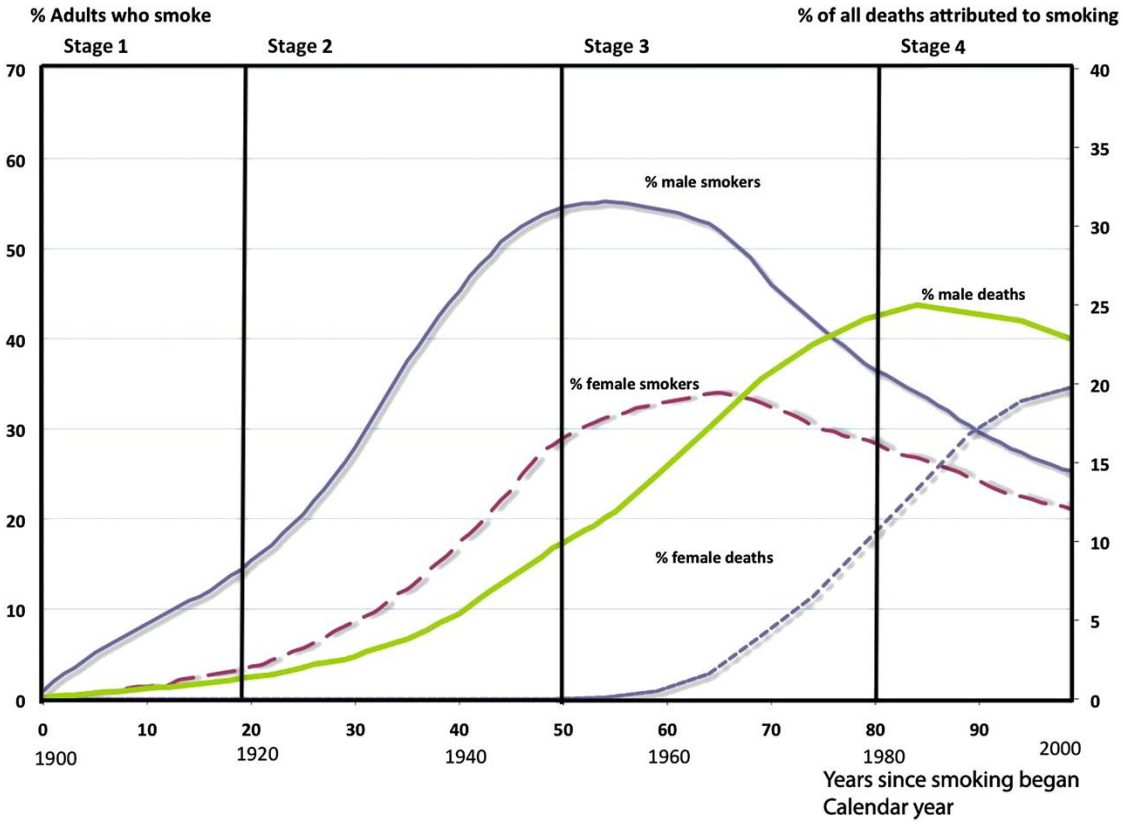

Figure 1 The smoking epidemic in economically developed countries
Source: (Thun, et al., 2012)

Increases in smoking related mortality typically lag 30 years behind significant increases in the smoking prevalence of youngsters and young adults. Post-1960, smoking prevalence decreased significantly amongst males, and post-1980 this decrease was followed by a reduction in male smoking related mortality, which continues to decrease. Due to the 20-30

year delay in their smoking uptake compared to men, smoking mortality rates amongst women continued to rise throughout the latter part of the 20th century and into the early 21st century.

Smoking prevalence for both males and females has continued on a downward trend over the past few decades. According to the General Household Survey (GHS), 42% of males and 36% of females smoked in 1980 (Table 1). By 1992 this reduced significantly to 28% and 27% respectively. Male smoking prevalence stagnated between 1992 and 2001 at 28-29% before slowly declining to 22% in 2009. In the earlier period, female prevalence slowly decreased from 27% to 25%. The decreases in male smoking prevalence only continued after the change of Government in 1997. The New Labour Government pledged to reduce the level of burden from tobacco in the UK. Smoking prevalence rates of males and females have converged since the 1980s and now only 2% fewer females' smoke (20%) compared to males. The most recent figures hint at another period of stagnation in smoking prevalence rates. This suggests that a renewed committal to tobacco control is required in order to drive down smoking prevalence to the 18.5% target by 2015 set out in the most recent 2010 *Healthy Lives, Healthy People* public health White paper (DH, 2011).

Smoking prevalence amongst children aged between 11 and 15 years of age is measured by the Smoking, Drinking and Drug Use Among Young People Survey (SDD). The most recently available figures are for 2010 (Bridges, Gill, Omole, Sutton, & Wright, 2011). Amongst this age group smoking prevalence rates are heterogeneous with increasing prevalence associated with increased age. Very few children aged 11 to 13 years smoke regularly. In 1982, 24% of 15-year-old boys and 25% of girls smoked regularly (Table 1). Prevalence rates for this age group have fluctuated greatly since in 1982 however, trends have shifted downwards, with girls having consistently higher prevalence than boys. In 2010, 14% of girls and 10% of boys reported regular smoking. Saliva samples gathered between 1990 and 1998 found that children were, for the most part, honest about their smoking behaviours and so fluctuations in prevalence rates from year to year are unlikely to be attributable to false reporting.

More than a century since the initiation of mass produced cigarettes, it is now widely accepted by health professionals, the Government, the general public and even by the tobacco industry that active smoking is a major cause of illness, disability and death worldwide. As this thesis focuses on the evolution of children's exposure to SHS, the health

impacts of active smoking are reviewed only briefly and the health impacts of passive smoking are focused on children.

1.2.2 Health impacts of active smoking

In the UK, a seminal British paper confirmed a link between smoking and lung cancer in 1950 (Doll & Hill, 1950).[1] This study was followed by others, 23 of which (from 9 different countries) which were reviewed by the Royal College of Physicians who, in 1962, reported that there was conclusive evidence of a causal link between smoking and lung cancer and smoking and bronchitis and that smoking played a contributory role in coronary heart disease (RCP, 1962). Over time both the RCP and the Surgeon General amongst others have continued to update and publish the accumulating evidence linking smoking to an increasing number of illnesses. It is now estimated that 85% of all cases of lung cancer are attributable to smoking (USDHHS, 2010). In comparison to other cancers, lung cancer has one of the poorest survival rates (American Cancer Society, 2010). In addition to lung cancer, active smoking is now also known to cause: heart disease, including peripheral vascular disease and stroke, cancers of the larynx, oropharynx, oesophagus, trachea, bronchus, stomach, pancreas, kidney and urethra, colon, cervix, bladder, acute myeloid leukaemia, chronic obstructive pulmonary disease (COPD), including emphysema and bronchitis, in addition to a range of other respiratory illnesses, periodontitis, pneumonia, cataracts and blindness, hip fractures and reduced fertility in both men and women (USDHHS, 1984, 1990, 2004). In 2010, the Surgeon General published a report which reviews the scientific evidence from hundreds of studies which have investigated the biological mechanisms linking smoking with illness (USDHHS, 2010). For example, exposure to carcinogens found in tobacco smoke is directly linked with DNA damage and it is this DNA damage that plays a causal role in the development of lung cancer. In the case of heart disease, smoking produces a chronic inflammatory state that contributes to atherosclerosis (thickening of the artery wall from fatty deposits). Elevated levels of inflammation are directly predictive of cardiovascular events. In terms of fertility, smoking leads to diminished female oviductal functioning which could impair fertilisation, after conception and the immuno-suppressive effects of smoking can be directly responsible for miscarriage and pre-term delivery.

[1] This link had also been found in Germany prior to 1950 but these research studies were not heavily publicised for political reasons.

Table 1 Prevalence of cigarette smoking among adults and amongst children aged 15

	% of respondents who smoke																					Base
	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008*	2009	2010	
Adults																							
Male	42	37	35	34	32	31	29	28	28	28	29	29	28	27	27	26	25	23	22	21	22	-	**15,101**
Female	36	32	32	31	30	28	27	25	27	26	26	25	25	25	24	23	22	21	19	20	20	-	**17,529**
Total	39	35	33	32	31	29	28	26	28	27	28	27	27	26	25	25	24	22	21	21	21	-	**11,310**
Children aged 15											1999												
Girls	-	25	28	27	22	25	25	30	33	29	25	26	25	26	26	26	25	24	19	17	16	14	**15, 089**
Boys	-	24	28	18	17	25	21	26	28	19	21	21	19	20	18	16	16	16	12	11	14	10	**15,900**

Source of adult data: The General Household Survey (S. Robinson & Bugler, 2010)

Source of child data: The Smoking, drinking and drug use amongst young people 2010 survey (Bridges, et al., 2011)

In men, the DNA damage caused by smoking can impair male fertility, the viability of the pregnancy after conception and future anomalies in offspring. The most recent Tobacco Atlas (Eriksen, et al., 2012) produced a comprehensive and lengthy list, presented in diagrammatical form, of illnesses and ailments that can occur as a result of active smoking (Figure 2).

According to a large longitudinal prospective study of doctors in the UK (which was launched in the UK in the 1950s just after the first links with lung cancer had been made in the UK), half of all long-term smokers will die from smoking related illnesses and half of these deaths will be in middle age leading to a loss of 20-25 years of life (Doll, Peto, Boreham, & Sutherland, 2004; Doll, et al., 1994; Peto et al., 1996). Furthermore, the list of illnesses that can be causally attributed to smoking continues to grow over time.

1.2.3 Health impacts of passive smoking

The health impacts of SHSe started to accumulate in the 1980s. In 1981, separate studies conducted by Hirayama and Trichopoulos found that non-smoking women exposed to SHS at home were at increased risk of lung cancer (Hirayama, 1981; Trichopoulos, Kalandidi, Sparros, & MacHahon, 1981). Hirayama followed non-smoking wives (*N* = 91,540*)* for 14 years between 1966 and 1979. The wives of smokers were found to be at increased risk of dying from lung cancer compared to women with non-smoking partners (Hirayama, 1981). There was a dose-response relationship between rates of lung cancer and levels of cigarette consumption of the partner. Despite severe criticisms and counter arguments to Hirayama's research led by the tobacco industry, Hirayama's work stood up to scrutiny and five years after its publication, 13 further studies had confirmed the link between passive smoking and lung cancer (Ong & Glantz, 2000).

Tobacco smoke is made up of over 7,000 chemicals, 69 of which are known causes of cancer (Eriksen, Mackay & Ross, 2012). Approximately 85% of SHS is side-stream smoke which comes from the burning tip of a cigarette and the remaining 15% is mainstream smoke which is exhaled by the smoker, with side-stream smoke confirmed as more toxic than mainstream smoke (Schick & Glantz, 2005, 2006). Approximately, 85% of SHS is invisible and odourless (National Research Council, 1986).

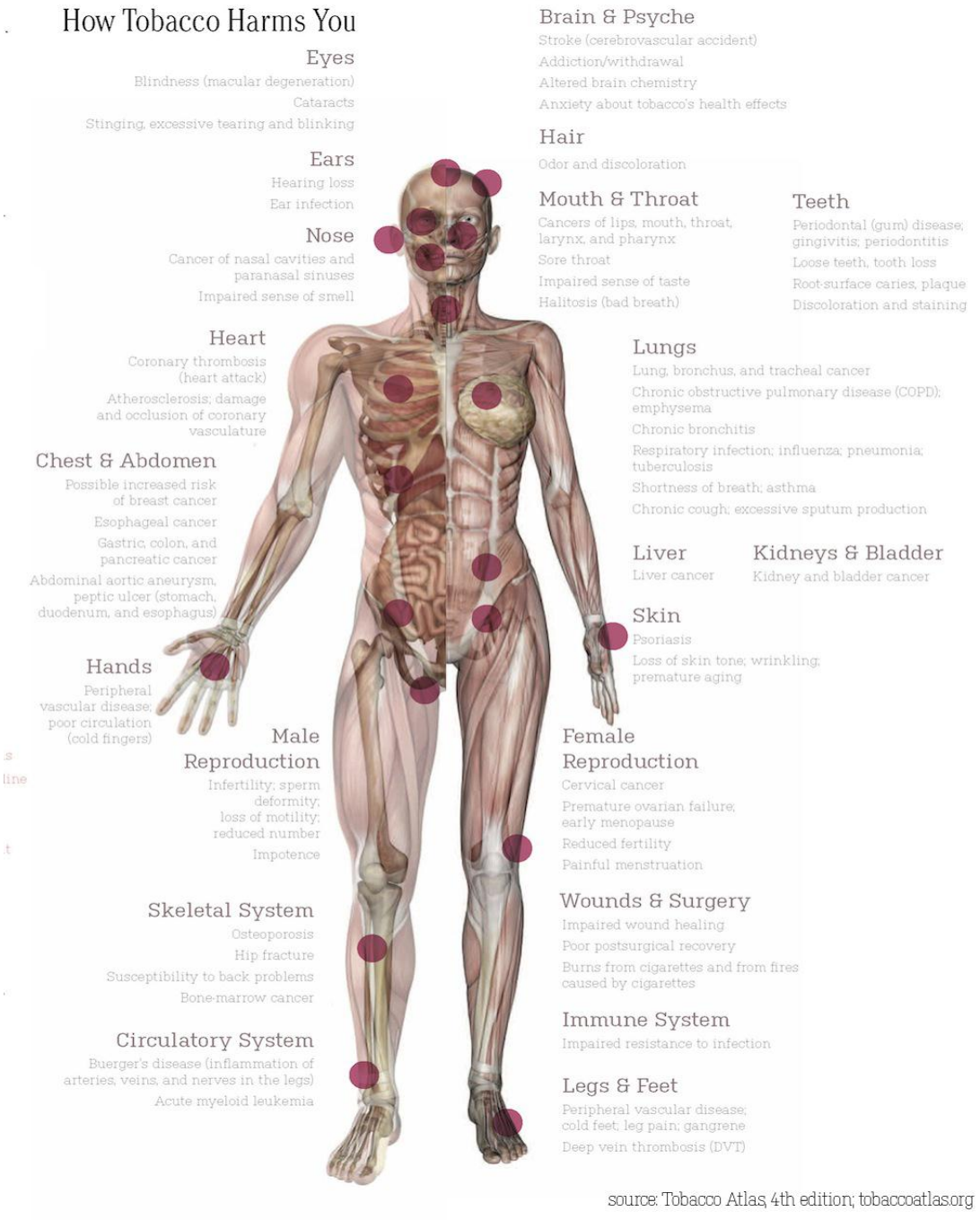

Figure 2 Health impacts of active smoking

Children are at higher risk of SHSe than adults; this is because research has found that at similar levels of tobacco smoke exposure, children have cotinine concentrations that are approximately 70% higher than those found in adults (RCP, 2010; Willers, et al., 1995). The authors of this research suggested that this is likely to be a result of the higher respiratory rates of children compared to adults (Willers, et al., 1995). As this thesis focuses on the SHSe of children only, the detrimental impacts of SHS on children only are discussed here. The literature assessing the link between SHSe and childhood illness is vast. There have

been several comprehensive systematic reviews of this literature (Cal EPA, 2005; SCOTH, 1998, 2004; USDHHS, 2006); most recently the RCP conducted an updated search of the health impacts literature post-2001 to extend the Surgeon General's 2006 report on the detrimental health effects of SHS (RCP, 2010). The RCP report provided the results of their meta-analyses which included all of the studies from the earlier reports in addition to those most recently gathered by the RCP, for each of the following illnesses: Sudden Infant Death Syndrome (SIDS), middle ear disease, respiratory illnesses such as lower respiratory infections, asthma, and wheezes. The findings of the RCP meta-analyses are summarised here.

Studies investigating children's likelihood of developing each illness has been explored relative to their SHSe. Some studies have focused on prenatal exposure where mothers' smoked during pregnancy, others have explored the risk of childhood illness by maternal exposure where mothers' have smoked around their children post-partum, fewer have explored the risks of illness following paternal exposure to SHS and finally some studies have assessed overall household smoking and its relationship with childhood illness.

There is strong evidence for a link between SHSe and SIDS for all types of exposure; maternal prenatal and postnatal smoking and paternal smoking exposure (Table 2). However, the odds of SIDS related to paternal exposure were considerably lower than those for maternal exposure. This is likely to reflect the fact that children generally spend more time in the immediate care of their mother.

Lower respiratory tract infection is a broad term that encompasses a range of respiratory illnesses. The meta-analysis included studies of the association between SHSe and bronchitis, bronchiolitis[2], pneumonia, acute respiratory infection and 17 further studies of unspecified lower respiratory infection. As with SIDS, lower respiratory infections were more likely in children exposed to SHS regardless of the type of exposure. When each specific lower respiratory infection was explored independently, the overall increased risk of lower respiratory infection could be mostly attributed to the robust relationship between SHSe and bronchiolitis. Nevertheless, despite the relationships being of lesser magnitude, each of the lower respiratory infections was positively related to SHSe.

[2] Bronchitis refers to the irritation and inflammation of the large bronchi of the lungs which causes mucus production and coughing, whilst bronchiolitis refers to the inflammation of the smaller bronchioles in the lungs which makes it harder for infants and children to breathe.

Wheezing is a high pitched whistling sound that occurs whilst breathing indicative of the narrowing of the airways and can be a symptom of respiratory disease. Studies measuring a child's first ever occurrence of wheeze were pooled into three different age categories, those aged 2 and under, 3 to 4 years and those between 5 and 18 years. SHSe was associated with increased risk of wheeze in all age groups for all exposure types (although there are no data for the relationship between paternal exposure for those aged 2 and under and 3 to 4 years). As was the case for SIDS and lower respiratory infections, risk of wheeze was highest for those children subjected to maternal exposure.

Whilst the role of SHS in the *exacerbation* of asthma symptoms is clear (USDHHS, 2006), the evidence for a link between SHSe and the *onset* of asthma has been more inconsistent. The RCP report concluded that the link between SHS and the onset of asthma for maternal prenatal smoking and maternal smoking in children's first 2 years of life was convincing. However, for those children aged between 5 and 18 years, the only strong association was found between *household* SHSe and onset of asthma. Whilst it is possible to say that for infants there was still substantial evidence of a clear link between SHS and asthma onset, further well controlled studies are warranted to help clarify this relationship.

Middle ear infection refers to a painful infection of the ear that occurs behind the ear drum. Maternal postnatal exposure is strongly linked to child middle ear disease, particularly severe cases that require surgery (OR: 2.90, 1.29-6.53; not included in Table 2). The link between maternal prenatal and paternal exposure was also more convincing for severe cases of middle ear disease rather than the somewhat less serious cases of middle ear infection.

In addition to the illnesses summarised in the RCP report, child SHSe has also been linked with the development of cardiovascular disease risk factors in children aged 8 to 11 and adolescents (Kallio et al., 2007; Kallio et al., 2010). In a longitudinal study, which took annual measures of cotinine from children between the ages of 8 and 11 years, there was a dose-response relationship between mean cotinine over time and endothelial dysfunction at age 11. Children were grouped into 3 categories; undetectable cotinine (<0.16ng/ml), low exposure (0.2-1.6ng/ml) and high exposure (>1.7ng/ml).

Endothelial dysfunction is a pathological state of the inner lining of the blood vessels and is a key event in the development of atherosclerosis (Endemann & Schiffrin, 2004).

Atherosclerosis is sign of cardiovascular disease and is a risk factor for a future cardiovascular event in adulthood such as heart attack or stroke.

In a further study using the same data 2 years later, 13 year olds who were frequently exposed to SHS between the ages of 8 and 13 had significantly increased arterial intima media thickness (IMT), an early marker of atherosclerosis (Kallio, et al., 2010). Again there was a dose-response relationship with greater exposure associated with increased IMT. The results in this study were again categorised into 3 groups, but this time the parameters were different (low: 0.10ng/ml - 0.39ng/ml; intermediate: 0.40ng/ml – 0.69ng/ml; high: 0.70ng/ml – 4.1ng/ml). Children of intermediate exposure and high exposure had significantly higher measurements for IMT than those in the low exposure group. Arterial IMT in the low exposure group was 0.527mm compared to 0.563mm in the intermediate exposure group and 0.567mm in the high exposure group. Amongst young people, the mean arterial IMT has been measured as 0.5mm (Ludwig, von Petzinger-Kruthoff, von Buquoy, & Stumpe, 2003). It is unclear from the results of this study whether those in the low exposure group (0.10ng/ml – 0.39ng/ml) are at significantly increased risk compared to those with undetectable cotinine. Kallio and colleagues argue that their research supports earlier research with adults (Barnoya & Glantz, 2005) that the negative impacts on the cardiovascular system are apparent even at low levels of SHSe.

Although the 2006 Surgeon General report concluded that there is no safe level of SHSe there is very little evidence on the impact of low levels of exposure indicated by low cotinine concentrations on child health. It has been found previously that although air nicotine disperses the further away you are from a burning cigarette, other toxic components do not dissipate (Lofroth, 1993). So even though cotinine is a good proxy measure of SHSe, it may not be the case that lower cotinine levels equate to reduced harm. However, it is not absolutely clear whether there are any detrimental impacts of very low exposures to SHS (0.10ng/ml-0.39 ng/ml). Nevertheless, cotinine levels are associated with tobacco-specific carcinogenic nitrosamines and therefore greater cotinine values provide a ‘reasonable surrogate’ indication of level of SHS-related illness risk (Hecht et al., 2001; RCP, 2005).

In summary, SHSe is causally linked to a number of illnesses in children which lead to significant morbidity and in the case of some illnesses, mortality. These illnesses are preventable, yet they burden the NHS with the significant costs of treatment. Furthermore,

there are also hidden costs to society from days lost at school and days lost at work by parents who have to stay home to care for sick children (Öberg, et al., 2011). Furthermore, the tobacco industry still does not wholeheartedly accept the health risks associated with SHS and takes opportunities to undermine the quality of the evidence as illustrated on some transnational corporations' homepages (British American Tobacco, 2012; Imperial Tobacco, 2012).

1.2.4 Tobacco control policy

The field of tobacco control has evolved over time, starting off in the UK in the 1950s with the increased awareness of a link between smoking and fatal illness (even though links between smoking and illness had been made earlier than this). In a climate of increasing tobacco control in developed countries such as the United States (US), the UK, Canada, Australia and New Zealand, just to name a few, smoking prevalence has declined, smoking-related illness has decreased and expenditure on health care for smoking-related illnesses is less than what it might have been without tobacco control initiatives. In the US reductions in tobacco use in the latter part of the 20th Century prevented approximately 146,000 male lung cancer deaths between 1991 and 2003 (Thun & Jamal, 2006). The following section (*1.2.4.1*) focuses on tobacco control measures in the UK and England specifically.

1.2.4.1. Tobacco control measures (1962-2000)

The publication of *Smoking and Health* in 1962 was the first official attempt to persuade the Government to implement policies in the tobacco field in order to curb the smoking epidemic. In the report, the RCP recommended:

- the education of the public regarding the proven dangers of smoking
- increased restrictions on tobacco sales to children
- restriction of tobacco advertising
- increases in tax on tobacco
- informing smokers of the tar and nicotine content of tobacco products
- the exploration of whether anti-smoking clinics might help people give up

Table 2 Summary of RCP (2010) meta-analyses of increased risk of child illness associated with SHS

Exposure	Relative risk of child illness compared to those with no second-hand smoke exposure (Odds ratio & 95% CI)								
	SIDS	LRI	Wheeze			Asthma			Middle ear disease
			≤2 years	3-4	5-18	≤2	3-4	5-18	
Prenatal maternal	2.94 (2.58-3.36)	1.24 (1.10-1.40)	1.44 (1.20-1.73)	1.25 (1.12-1.40)	1.38 (1.19-1.60)	1.91 (1.43-2.54)	1.24 (0.93-1.64)	1.22 (1.13-1.34)	1.11 (0.55-2.24)
Number of studies	73	9	11	7	5	4	2	5	4
Maternal	3.15 (2.58-3.85)	1.58 (1.45-1.73)	1.72 (1.15-2.58)	1.77 (1.18-2.67)	1.65 (1.14-2.41)	0.70 (0.04-11.23)	1.04 (0.87-1.25)	1.15 (0.99-1.34)	1.46 (1.21-1.76)
Number of studies	16	31	2	4	2	1	3	5	18
Paternal	1.45 (1.07-1.96)	1.22 (1.10-1.35)	-	-	1.31 (1.01-1.70)	-	1.34 (1.23-1.46)	0.90 (0.44-1.83)	1.27 (0.97-1.66)
Number of studies	8	21	-	-	2	-		1	10
Household	-	1.54 (1.39-1.89)	1.37 (1.08-1.73)	1.06 (0.88-1.27)	1.34 (1.15-1.56)	1.17 (0.95-1.44)	1.21 (1.00-1.47)	1.50 (1.13-1.97)	1.35 (1.23-1.49)
Number of studies	-		7	4	5	2	5	4	46

Note: SIDS – Sudden Infant Death Syndrome; LRI – Lower Respiratory Tract Infections **Source: RCP (2010)**

This report gained widespread coverage and was given further impetus two years later when the Surgeon General's Report was published in the US reinforcing the negative impact of smoking on health and further fuelling debate on the topic. Since this time, the field of tobacco control has expanded inexorably in the UK as a result of sustained campaigning and increased involvement of Government to curtail the actions of the tobacco industry and to convince individuals to give up smoking. In 1971, the RCP established Action for Smoking and Health (ASH) to achieve the recommendations set out above. ASH has relentlessly championed the merits of tobacco control initiatives ever since. Changes in the UK are nested within the broader context of international developments in this field (Figure 3).

It is known that tax increases are one of the most effective ways to reduce smoking prevalence, with youth smoking being particularly sensitive to price increases (Townsend, Roderick, & Cooper, 1994). Tax increases were levied regularly from the mid-1960s above the rate of inflation (Celanese Fibers Company, 1964). In 1965, television advertising of cigarettes was banned but advertising of other tobacco products was still permitted through this media and adverts for all tobacco products remained widespread in print and on billboards. Whilst great advances in tobacco control were being made, these early years of tobacco control were characterised by voluntary agreements between the Government and the tobacco industry, which in retrospect, were found to be largely ineffective and acted as a valuable industry stalling tactic for more formal policy interventions (Berridge, 2007). At this time the tobacco industry was heavily engaged in Government and had strong influence over public health policy decisions (Nathanson, 2005).

The New Labour Government, which came into power in 1997, pledged its commitment to tobacco control with the publication of the White paper *Smoking Kills* in 1998, which renewed the above recommendations and set goals to reduce national prevalence and end all forms of tobacco industry advertising including sports endorsement (DH, 1998). A number of other goals were set out in *Smoking* Kills, including a plan to deter youngsters from starting to smoke and persuade current smokers to quit. To achieve this end the Government planned to; decrease the affordability of cigarettes by increasing tax on each pack, change attitudes towards smoking via education and mass media and to introduce Stop Smoking Services (SSS) funded by the NHS. To reduce exposure to SHS the white paper proposed that restaurants and bars consider non-smoking areas. In order for these

proposals to have any impact, the Government acknowledged it was essential that they eliminate tobacco advertising and sponsorship (DH, 1998).

1.2.4.2. Post 2000

A full advertising ban (apart from tobacco packaging and point of sale displays) which had been advocated for over two decades was eventually passed in 2002 and fully achieved when Formula 1 removed all tobacco branding from their teams for UK audiences in 2005. Other major developments since *Smoking Kills* were the creation of NHS SSSs, and following the Health Act in 2006, SFL and an increase in the age of purchase of cigarettes to 18. Also under the Labour Government, the 2009 Health Act laid out plans to remove all cigarette vending machines in 2011 and prohibit point of sale advertising by the end of 2013. In December 2011, all vending machines were removed in England. Furthermore, the Coalition Government has now implemented the point of sale advertising ban in England, with large supermarkets having to cover up point of sale displays of tobacco products as of April 2012, with smaller retailers forced to comply by 2015. In line with the recommendations of *Smoking Kills* regular anti-smoking mass media campaigns have been conducted regularly throughout the first decade of the 20th Century. Between 2003 and early 2007, campaigns focusing on the detrimental impacts of SHS were conducted. These were replaced by campaigns advertising the SFL in April 2007. There have been numerous mass media campaigns since which have focused on active smoking. April 2012 witnessed the first *national* SHS-related mass media campaign since the *Invisible killer* campaign ended in 2007.

The Coalition Government published their tobacco control plan for England subsequent to their Public health White paper in March 2011 (DH, 2011). The plan emphasised that the most effective approach to tobacco control must be multi-faceted and operate at different levels of society[3]. The Government aims to reshape social norms around smoking behaviour making tobacco use less normal and less desirable amongst the youth. The Government place most responsibility with local areas to decide on their own priorities in their communities based on national and local evidence bases. The White paper outlined three national goals that require multilevel interventions:

- reduce adult smoking prevalence to 18.5% by 2015

[3] This standpoint is consistent with the recommendations of the ecological approach that is discussed in more detail in chapter 2.

- reduce smoking prevalence of 15 year olds to 12% by 2015
- reduce smoking prevalence during pregnancy to 11% or less

To achieve these ends the Government outlines a number of policies:

To limit the availability of tobacco products by continuing to increase the tax on cigarettes above the level of inflation in order to drive down prevalence *Smoking Kills* also outlined an aim of increasing tax by 5% above inflation annually but in reality prices have remained close to inflation since 2001 (ASH 2008). In order to ensure the efficacy of price increases in limiting the availability of tobacco to the poorest smokers, the Government has expressed its commitment to increasing the resources spent on reducing smuggling of illegal cigarettes into the UK.

Australia is set to become the first country in the world to introduce plain packaging in December 2012. The UK Government launched a public consultation to gather evidence on the potential impacts of plain packaging to run between 16th April 2012 and the 10th Augest 2012 (extended from 10th July). The tobacco industry and its supporters have been very vocal in their opposition and have been encouraging retailers and the general public to respond with counter-arguments to the proposed legislation. It is feared, that at present, stagnation in smoking prevalence rates in England is occurring, and there is concern that prevalence may even rise if tobacco control activities do not continue. Therefore, there is a real need for research to support the continued action of the Government policy interventions in tobacco control.

According to the Government tobacco plan, initiatives need to be implemented at a number of different levels in a multi-faceted approach to decreasing smoking and SHSe in the UK. At an organisational level, it was proposed that health and social care workers ought to receive training to engage smokers in conversations about quitting and that an opt out system of referral to stop smoking services should be implemented. Whilst the former is likely to provide smokers with more opportunities to talk about quitting, an opt-out referral system may provoke with a 'nanny state' backlash. The White Paper also suggested that there is a need to diversify the options of how to quit so that each quit attempt is tailored to smokers' needs thereby increasing their chances of success. At the local community level, health authorities are to be encouraged to develop tobacco control strategies that incentivise quitting and protecting others from SHS. At the national level,

mass media campaigns ought to be used to influence smoking behaviour by increasing individuals' knowledge of the dangers of smoking and SHS. To achieve this end, a national campaign aimed at increasing the prevalence of smoke-free homes was launched in April 2012 and is due to run until the end of May 2012. The current White Paper proposes that mass media interventions and community level interventions should be used to educate smokers of the dangers to others and encourage them to voluntarily make indoor environments (including cars carrying children) smoke-free.

Whilst the Government has expressed commitment to protecting non-smokers from the harms of SHS, it has not proposed any further legislative interventions in the White paper. This is despite the RCP's call to make smoking in cars with children illegal. Whilst the proposed legislative measures of *Healthy Lives, Healthy People* are not specifically aimed at reducing the SHSe of children in the home, tobacco control measures that further denormalise smoking may have knock on effects on parental home smoking behaviour.
From the 1990s, the enhanced tobacco control activity in the UK has coincided with global developments in tobacco control. Therefore to place the developments in England in context, some key international developments since the 1990s are discussed in the next section.

1.2.4.3. International context

In the late 1990s, the World Bank engaged in tobacco control, publishing its seminal report on tobacco control in 2000 (Jha & Chaloupka, 2000). Around the same time the World Health Organisation (WHO) established the Tobacco Free Initiative and negotiations for what eventually became the Framework Convention for Tobacco Control (FCTC) commenced.

The World Bank report (World Bank, 2003) stressed six main strands by which tobacco control measures could be used to reduce and potentially eliminate tobacco use.

1. Stop the promotion of tobacco through comprehensive bans on advertising including logos and branding
2. Make tobacco less affordable through tax increases
3. Strongly regulate tobacco products with health warnings
4. Help users quit by increasing access to medications and behavioural support
5. Reduce SHSe by banning smoking in public places

6. Communicate with the public on the risks of tobacco and the benefits of tobacco control

The key message coming from the global forums was that effective tobacco control requires comprehensive policies covering a number of factors that facilitate continued smoking. To this end and in order to tackle the globalisation of the tobacco epidemic, the WHO developed the FCTC. The first global public health treaty, the FCTC, reaffirmed the rights of all to the highest standard of health. The treaty came into force in February 2005 and has since become the most rapidly and widely embraced treaty in United Nations history with over 172 countries, including the UK, becoming signatories by 2012. The FCTC outlines several evidence-based smoking reduction strategies including price and tax measures and non-price measures to reduce the demand for tobacco. The latter included protection from exposure to tobacco smoke, education, communication, and public awareness. Those who have ratified the treaty are legally bound to reduce the harm caused by tobacco. Additionally, at EU level in 2003, the European Commission applied additional pressure by explicitly calling for EU member states to provide protection from exposure to tobacco smoke in indoor work places, enclosed public places and public transport. However, this is only a recommendation rather than a legally binding obligation. Subsequent reports such as the WHO MPOWER reports in 2008 and 2011 have renewed these commitments (WHO, 2008, 2011).

Policies aimed at reducing SHSe are of particular interest in this thesis and therefore both the SFL and the use of SHS-related mass media campaigns are introduced in some more detail here.

1.2.4.4. Smoke-free legislation

In 1998, California became the first state in the US and the first place in the world to implement a comprehensive SFL which prohibited smoking in indoor public places and workplaces. Many additional states have since become smoke-free. Ireland was the first country in the World to enforce comprehensive SFL in 2004 (Callinan, Clarke, Doherty, & Kelleher, 2010; IARC, 2009). In March 2006 Scotland became the first country in the UK to implement SFL. The Health Act which covered England, Wales and Northern Ireland received royal assent three months later in July 2006 and SFL was implemented in April 2007 in both Wales and Northern Ireland and 1st July 2007 in England. Achieving SFL in England was a long fought battle built upon the evidence of positive impacts of the

legislation in other countries and framed in the broader context of the FCTC international treaty.

1.2.4.5. Mass media

It is difficult to acquire historical data on mass media campaigns, how long they ran for and how effective they were. There is evidence from the California Tobacco Control Program (CTCP) that anti-smoking advertising in California was effective in countering the advertising of the industry and driving down smoking prevalence in the 1990s during the years in which industry advertising was still allowed (Pierce, Emery, & Gilpin, 2002). However, it was recognised in England, that as long as tobacco industry advertising was permitted, progress in tobacco control would be limited (DH, 1998). The Smoke Free Resource Centre for England has produced a timeline of anti-smoking mass media campaigns from 1985-2012 (DH, 2012). However, given that other campaigns are discussed in other literature, there is reason to believe that this timeline does not offer a comprehensive list (Kosir & Gutierrez, 2009). Furthermore, regional offices for tobacco control have conducted their own campaigns over the years. Again acquiring comprehensive data on these campaigns is difficult as there is no central repository that holds all of the relevant information. Nevertheless, there is some evidence of the efficacy of anti-smoking mass media campaigns in England (McVey & Stapleton, 2000; NICE, 2000). Mass media campaigns focused specifically on getting smokers to protect others from SHS ran nationally in England between 2003 and early 2007 as aforementioned.

2003 & 2005: *If you smoke, I smoke*

This campaign was centred on images of children in every day scenarios (running around, playing, and drawing) with smoke going into their mouths and noses as they breathed. The ads gave information about the health problems children could experience as a result of SHSe.

2005: *Second-hand smoke is a killer*

This ad focused on smoking around people in general, not just children. A television ad was aired showing one person smoking in the home whilst other family members watched television, the smoke from the cigarette was shown snaking around the other people, around their necks and then turning into an evil face above their heads. The narrator advises that SHS can restrict the oxygen around the heart, causing it to fail and that smoking around your family increases their risk of heart disease by 25%.

2006: *Smoke is Poison*

This ad is not mentioned on the Smoke free Resource Centre webpage but is mentioned in Kosir and Gutierrez (2009). Television ads were created showing famous investigative journalist, Donald MacIntyre, conducting interviews with people that work directly with toxic chemicals, asking them about safety precautions they have to take with such substances, before revealing that the same chemicals are in tobacco smoke.

2007: *Invisible Killer*

This ad depicted the risks of SHS in public places by showing wedding guests (everyone from the bride and groom, to children under the table) inhaling invisible tobacco smoke from a cigarette being smoked at one of the tables. The narrator explains that SHS increases the risk of heart disease.

Other than the data reported by the British Market Research Bureau's Access Omnibus Survey, there has been no attempt to systematically review the evidence of the specific impact of SHS mass media campaigns in England and none of the BMRB evaluations have been rigorously peer-reviewed or published in academic journals, nor are evaluations of each campaign easily accessible online. According to information presented in Kosir and Gutierrez (2009), BMRB survey results in June and Sept 2003, February 2004, May and June 2005 and November 2006 and January 2007 were used to evaluate the impact of the above campaigns. The results from the May-June 2005 evaluation of *If you smoke, I smoke* are presented here. In June 2005, 66% of smokers reported taking some form of action either to reduce the SHS of others or to reduce their smoking altogether, this had increased from 58% following the last wave of advertising (COI, n.d). Whilst these results are positive, no statistical tests or confidence intervals are presented and it is unknown whether any confounding variables are taken into consideration. The BMRB evaluation reported that the there was an increase in the proportion of smoke-free homes from 49% at the end of 'wave 3' (date not mentioned) to 58% in June 2005. No stratifications of these proportions by smoking status or presence of children in the home were provided. (COI, n.d). Given this methodologically weak evaluation there may be a case to evaluate the impact of SHS-mass media campaigns retrospectively using routinely available survey data. However, as previously mentioned this is likely to be fraught with problems given that there is no comprehensive resource providing complete information on SHS-related campaigns in England. The potential impact of mass media campaigns on SHS related behaviour,

including the limitations of such campaigns and their evaluations are discussed later in this thesis.

1.3 Rationale for the research

Approximately 22% of all children in England were exposed to SHS in 2007, this proportion increased to 63% of children with at least one smoking parent and 79% of children who had two smoking parents (RCP, 2010). There is little convincing evidence about what can be done to reduce this exposure (NICE, 2009; Priest et al., 2008; Roseby et al., 2002). Children do not choose to be exposed to tobacco smoke and have little power to limit their exposure to parental smoking in the home which is now the predominant source of child SHSe. Given that a number of tobacco control policies have been enacted over the years and that smoking prevalence has been declining gradually over time, gradual reductions in child SHSe are to be expected. Although a number of studies have evaluated the impact of SFL on children's SHSe, it would be naïve to expect the SFL to have large impact for a number of reasons. First, these policies take time to change engrained behaviour which is underpinned by a complex spectrum of determining factors, second, reducing smoking in the home was not an explicit aim of the SFL and third, it is possible that, despite that despite the overall decline in smoking prevalence, SFL could lead to a displacement of parental smoking from public places and the workplace into the home. To date evaluations of SFL have focused on displacement. As explored in the following chapter, there is also some evidence on the determinants of children's exposure but the majority of these studies do not look at the multivariate relationships between determinants and children's exposure and have not explored England post-SFL, therefore, this is a gap that requires bridging.

Furthermore, as total behaviour change that requires commitment and effort often occurs as a process rather than a one off event (Hovell, Lessov-Schlaggar, & Ding, 2011), it is arguably the case that change in knowledge of the illnesses caused by SHS and partial changes in smoking behaviour in the home, during a period of sustained tobacco control efforts, may be indicative of changing social norms which may lead to changes in behaviour in the longer-term. To date there has been no formal quantification of partial measures to reduce SHS in the home and it is unclear whether partial smoking restrictions in the home offer any protective health effects to children.

Whilst, some of the determinants of SHSe in children have been explored previously, few studies have used routinely available data or statistical techniques which account for confounding effects of each of the predictors on the other. It is also unclear whether the characteristics of the child exposed, the characteristics of the household or the characteristics of the area in which they live are the most important predictors of children's exposure. Few have explored all of these factors in the same study. Furthermore, very few have explored the possibility that smoking behaviour differs by geographical area. It is important to know at which level determinants have the most influence on exposure so that future interventions are appropriately pitched. This is a key issue that needs to be addressed.

Knowledge is an important prerequisite for changes in attitudes and behaviour (Farquhar, Maccoby, & Solomon, 1984; Janz & Becker, 1984b; Klesges et al., 1988; Nourjah, Wagener, Eberhardt, & Horowitz, 1994; Potvin, Richard, & Edwards, 2000; Siahpush, McNeill, Hammond, & Fong, 2006; Stead, MacAskill, MacKintosh, Reece, & Eadie, 2001). The impact of mass media campaigns highlighting the dangers of SHS might be expected to improve people's knowledge of the illnesses that can be caused by SHS. In 2003-2006 frequent mass media campaigns that focused on SHSe in the home were aired yet any subsequent changes in knowledge of SHS-related illnesses and in home smoking behaviours have not been formally assessed. It may be the case that these campaigns and the publicity leading up to the implementation of the SFL, educated parents on the harms of SHS to their children.

Given that very little is known on how best to achieve smoke-free homes, it is imperative that the most important determinants of children's SHSe are uncovered in order to improve the quality of life of individual children who are currently exposed to tobacco smoke in the home and reduce the burden of childhood illness on the NHS and society in general. By exploring the levels and determinants of children's SHSe, future interventions are likely to be more effective in reducing SHSe in the home.

Furthermore, in light of the tobacco industry's ability to sway public opinion and instil doubt in Government about the efficacy of proposed tobacco control policies (Berridge, 2007; Nathanson, 2005), a comprehensive approach to tobacco control must be strongly supported by a watertight evidence base in order to convince policymakers that further

legislation (particularly in the case of plain packaging) and multilevel interventions are fundamental in the battle to denormalise smoking behaviour.

1.4 Aims & objectives

The aim of this thesis is to understand to extent of, and the factors underlying, children's exposure to SHS in the home in England, and the scope for interventions, mass media campaigns specifically, to change smoking behaviour in the home thereby reducing children's exposure. This will be achieved through secondary data analysis, notably analysis of survey data, using measures of self-reported and biologically validated SHSe amongst children. This PhD therefore aims to inform the development of effective public health policies post-SFL that will reduce children's SHSe.

Objectives:

1. To assess the trends in and the nature of self-imposed household smoking restrictions in England.

2. To explore the proportion of children post-SFL living in homes with total and partial home smoking restrictions, using a mixture of self-report and biologically validated cotinine data.

3. To assess whether partial smoking restrictions are effective in reducing children's SHSe by comparing cotinine concentrations of children living in homes with different home smoking policies.

4. To use an ecologically driven framework to explore the multilevel determinants of children's exposure to SHS post-legislation.

5. To explore trends in parental knowledge of the impacts of SHS and the association between knowledge smoke-free home prevalence.

6. To evaluate the impact of mass media campaigns on knowledge, and home smoking policies.

7. To evaluate the impact of a local mass media campaign on the prevalence of smoke-free homes.

It is noteworthy that analysis using data from each of the surveys used (OS, HSE and YouGov), the most recent data available were utilised in this thesis. Whilst trends in self-imposed smoking restrictions were explored from 1996 to 2008[4] (the latest available year for OS data) other issues were explored only in the period following SFL. The aim was to explore the contemporary issues using the most contemporary data available.

[4] 2008 data were collected in February and March 2009 due to a sampling error in 2008.

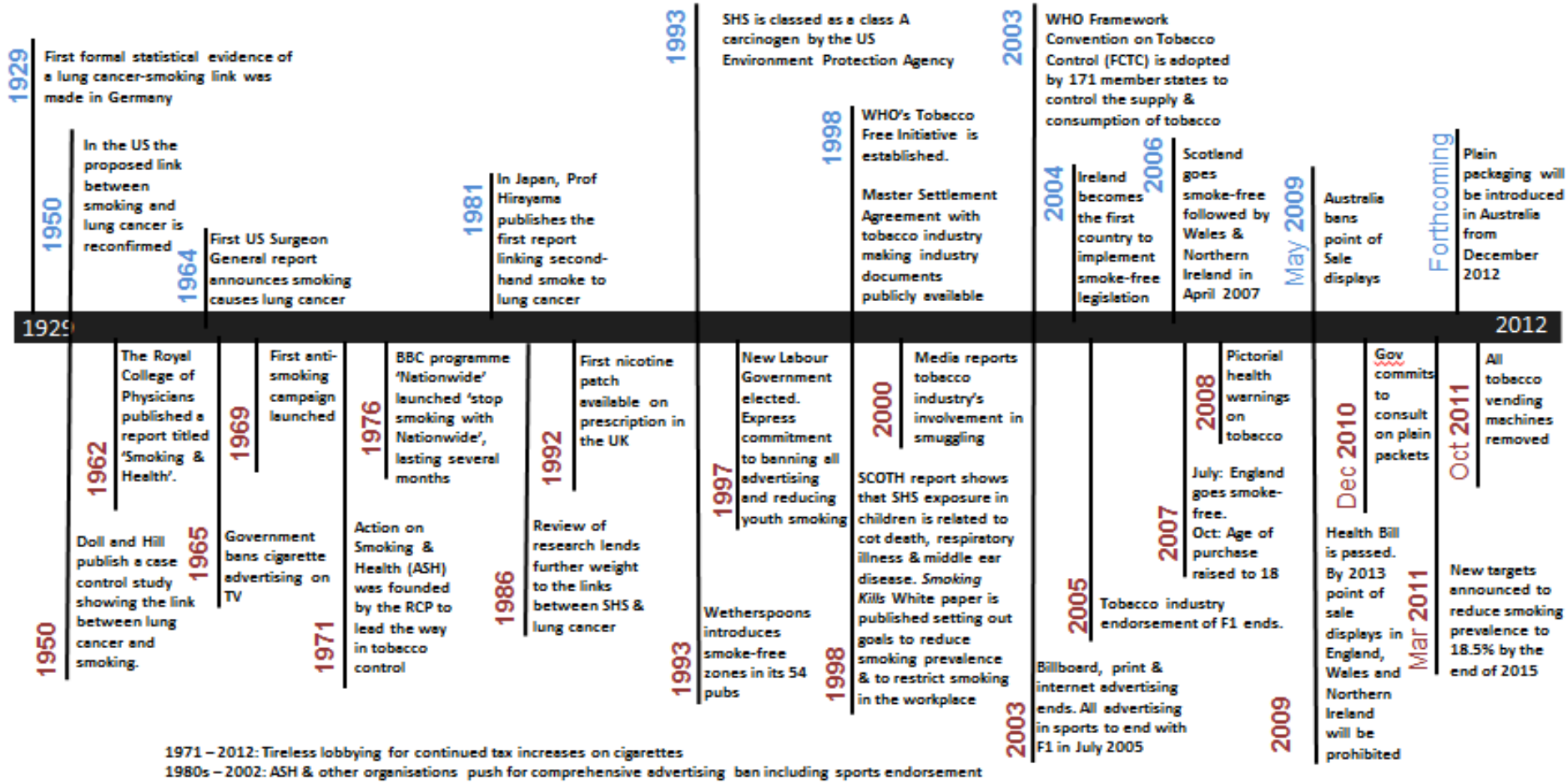

Figure 3 Important milestones in tobacco control, internationally (blue) and in England (Red)

CHAPTER 2. BACKGROUND: BEHAVIOUR CHANGE, SMOKE-FREE, SECOND-HAND SMOKE & MASS MEDIA CAMPAIGNS

In this chapter a comprehensive background to the thesis is provided. First, the principles of behaviour change are discussed with regard to the potential impact of multilevel interventions on individual behaviour and its determinants. Second, the impact of a population level intervention (SFL) aimed at behaviour change will be discussed. Its intended impacts, such as the reduction in SHS in indoor public places, are briefly discussed, before other secondary impacts such as children's exposure to SHS in the home and the health impacts on children are discussed. Third, this chapter examines factors that are associated with children's exposure to SHS in the home based on the existing evidence of the individual characteristics of the child, interpersonal factors, household level factors and area level factors. Finally, in addition to the determinants above and a number of others discussed in this chapter, the potential impact of mass media campaigns on children's SHSe is discussed. Together these four sections set the scene for the forthcoming analyses chapters 3, 4, 5 and 6.

2.1 Behaviour change

There is no single factor or even set of factors that can perfectly explain why people behave in the ways that they do. In an attempt to explain health behaviour and promote changes in health behaviours, researchers have proposed many different theoretical models. These models provide a systematic view of the relationships between different variables and behaviour change (Glanz, Lewis, & Rimer, 1997a). Behavioural interventions that are driven by theory can help produce changes in the initiation of a behaviour (such as the uptake of healthy eating or exercise), help provoke cessation of a behaviour (such as persuading people to give up smoking), *or* effect a qualitative change in a pre-existing behaviour (such as reducing the amount of alcohol consumed on a weekly basis)(Glanz & Bishop, 2010; Kok, Schaalma, Ruiter, Van Empelen, & Brug, 2004).

In 1979, the US Surgeon General's report on health promotion and disease prevention emphasised the importance of health promotion activities that aimed to modify individuals' lifestyle choices in order to improve health outcomes. As a result, behavioural interventions were frequently aimed to influence the individual motivators of, and barriers to, behaviour

change (Stokols, 1996). Health behaviour models, social psychological models or social cognition models are terms often used interchangeably to describe different theories that have been used for decades to help predict and explain health behaviours at the individual level. Some of these individual level theories focus on cognitive determinants of behaviour (e.g. beliefs, thought processes, attitudes) whilst others focus on affective determinants of behaviour (e.g. fear, perceived susceptibility to illness) (Crosby, Kegler, & DiClemente, 2002). Examples of popular theories include the Health Belief Model, Social Cognitive Theory, Theory of Reasoned Action (later becoming the Theory of Planned Behaviour) and the Trans-Theoretical Model (commonly known as Stages of change theory). Such models are undoubtedly of use when planning behaviour change interventions; however all of these health behaviour theories and models focus on the intrapersonal determinants of behaviour. These theories were extensively used in the 1980s and 1990s and are still used today, although a broader range of theories are now in use and it is commonly the case that constructs from several different theories are amalgamated and utilised to build behaviour change interventions that are tailored to a particular behaviour (Abraham & Michie, 2008). Increasingly the broader social and environmental determinants of behaviour are also being considered in modifications to existing models.

However, these models still mostly assume rather rigid linear cause-and-effect relationships which are too simplistic to explain complex human behaviour. In the case of behaviour change, even if all the individual determinants of the proposed behaviour are sympathetic to behaviour change, if the social conditions or the environment are not sympathetic then the desired change in behaviour might not occur. The consideration of interpersonal, organisational, community and policy level determinants of behaviour, their relationship with one another and their relationship with behaviour change is known collectively as the *ecological approach* which is also commonly referred to as a *broad systems approach* (Richard, Gauvin, & Raine, 2011; Sallis & Owen, 2008) This perspective is not new but it was relatively unheard of between the 1970s and the 1990s during the strong dominance of individualistic theories. However, more recently, in the last decade or so there has been a gradual resurgence of the ecological perspective in the field of behaviour change (Glanz & Bishop, 2010; McLaren & Hawe, 2005). This does not mean that earlier individualistic models are of use; they still elucidate important relationships and can be incorporated within a broader framework of influence.

The ecological approach is predominantly used as a qualitative framework to guide observational research; however it is also possible to use the approach experimentally where appropriate data are available. In a quantitative context the ecological approach has been formalised through the use of multilevel analysis. In a behavioural context, multilevel analysis explores the contribution of determinants of behaviour change at the individual, interpersonal, community (local or society at large) and policy levels (Figure 4). Individual level determinants of behaviour are nested within the interpersonal level which in turn is nested within the community level which is nested within the population public policy level. Multilevel analysis can assess the unique contribution of each predictor and also the unique contribution of each level of predictors by controlling for the effects of other predictors both within and between levels.

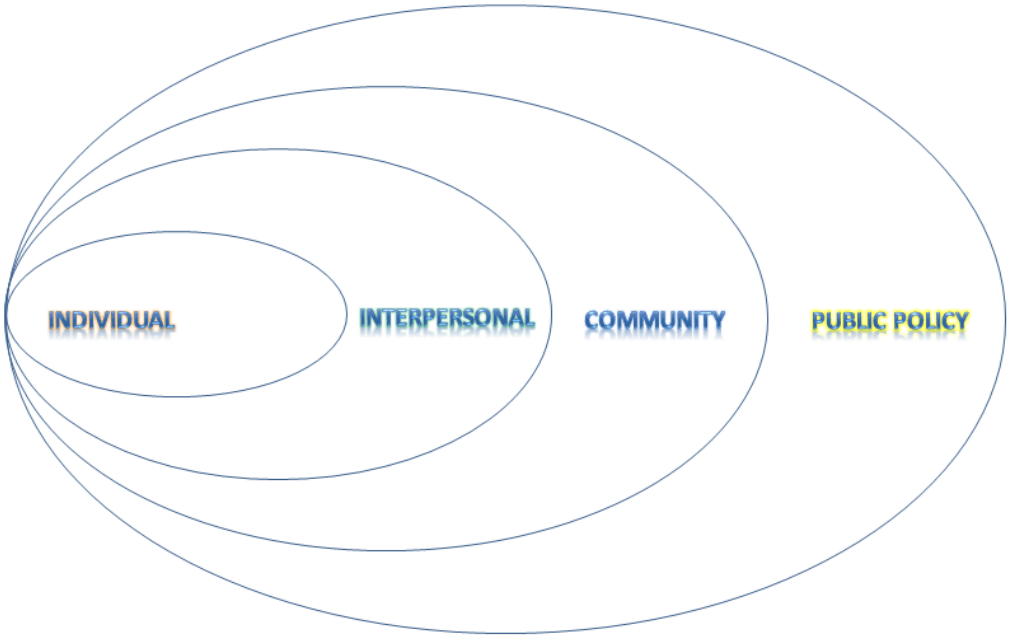

Figure 4 Ecological model of the levels of behavioural influence
Source: Based on Bronfenbrenner (1989)

As a framework, ecological approaches can be used to promote changes at more than one level in order to exert an influence individual behaviour. Whilst the SFL was not explicitly designed using any theoretical model, the approach taken by tobacco control in general can be considered ecological. Sallis and Owen (2008) reported that the most impressive application of multilevel approaches has been in the field of tobacco control. They suggested that individual level interventions in isolation have historically had limited success and so a multitude of interventions at different levels have since been utilised in

order to drive down smoking prevalence. For example, at the policy level, increases in taxation, the provision of SSSs, a comprehensive advertising ban and more recently the SFL, increasing the age of purchase to 18 and removing cigarette vending machines, have all contributed to the reduced the availability of cigarettes and have played a role in the continued denormalisation of smoking (Hovell & Hughes, 2009). Furthermore, at a national and regional level the use of mass media campaigns have also been used to contribute to the denormalisation of smoking behaviour by attempting to change individual's knowledge of the dangers associated with smoking, their attitudes towards smoking and, in the case of those who would like to give up, feelings of self-efficacy as they promote SSSs that smokers can access should they wish to. The constructs that are included in most social cognition models. The efficacy and limitations of mass media campaigns are discussed later in this chapter. Economos, et al (2001) reviewed the efficacy of multilevel approaches in various health promotion areas and concluded that the elements of success were Government involvement, mass communication, and environmental change guided by policy.

To illustrate the usefulness of ecological theory in behaviour change the following study is presented. Herbert, Gagnon, Rennick et al (2011) utilised the ecological approach as a framework in a qualitative study to explore the barriers and facilitators perceived by parents in relation to implementing smoke-free homes in Canada. Interviews were conducted and the key barriers and facilitators were coded into themes related to individual factors, interpersonal factors (including child factors and factors related to other family members), and the physical environment. At the individual level, parents reported that their level of addiction was a significant barrier to outdoor smoking, as was the time and effort required to make a change. It was also apparent that at the individual level there was a lack of knowledge about the dangers of SHS. At the interpersonal level, the supervision of children, the hassle of having to prepare children to go outside and the need for the child to stay close to the parent all acted as barriers to implementing a smoke-free home. Furthermore, a conflict about indoor smoking was reported when other smokers were present in the home (partners, other family members) who did not wish to implement smoke-free rules. This presents a considerable challenge to the person trying to enforce change, particularly if this person is not the home-owner. Broader environmental factors were also very important, e.g. the weather and the lack of access to the outdoors particularly those living in high rise apartments with no balcony. Although physical and social environmental factors were considered in this study i.e. outdoor space and interpersonal relationships with others, no community or policy level factors were

considered. Given the range of personal, interpersonal and environmental factors found in this study, these results highlight the importance of interventions that utilise the knowledge base provided by social cognition models and go beyond these individual determinants of smoking behaviour.

In order to guide public health practice and future interventions, Maibach et al (2007) proposed a framework of health behaviour called the 'people and places' framework (Figure 5). This framework aggregates the characteristics of individuals and the characteristics of their environments that have previously been shown to have an impact on health behaviour. Individual determinants of behaviour are nested within the social networks and communities in which people live their everyday lives. Attributes of the environment can operate at both a local and broader societal level (distal).

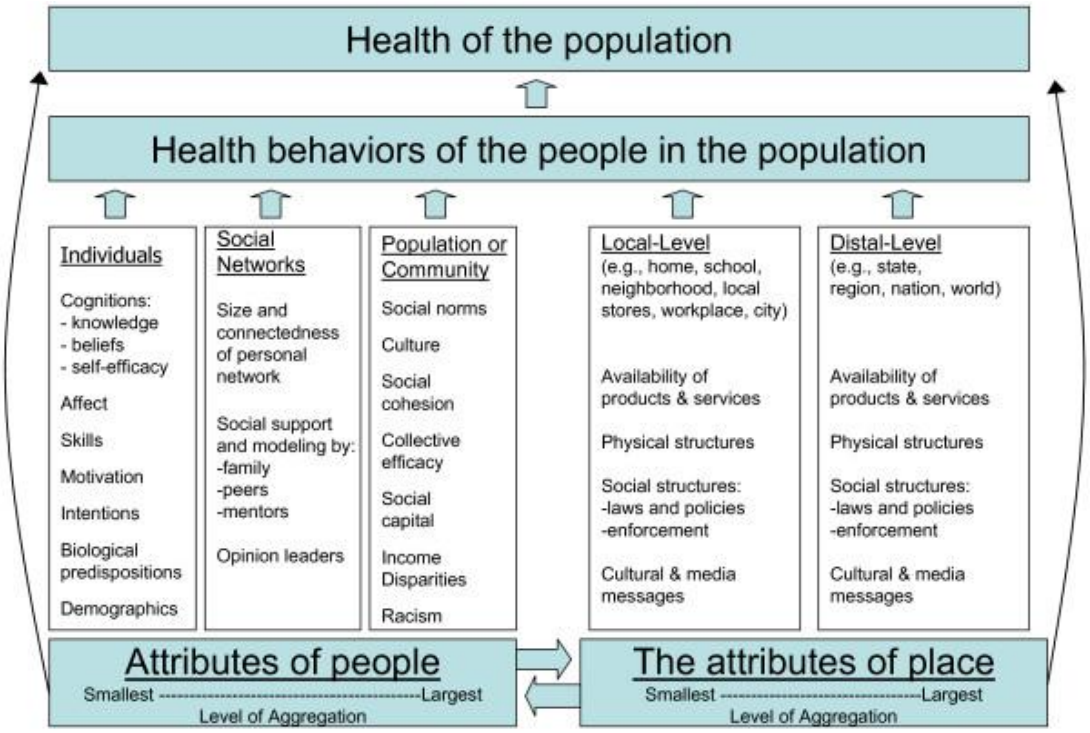

Figure 5 The 'people and places' framework of health behaviour
Source: Maibach et al (2007)

The authors summarised the literature on the individual determinants of health and concluded that there is sufficient evidence that perceived self-efficacy to perform a behaviour, as well as levels of knowledge, motivation, affect towards, and intentions to perform the behaviour, in combination with genetics and demographic factors are all

associated with health behaviours. In addition to individual level factors the size and connectedness of individuals' social networks play an important role in individuals' health behaviours including the perception of good social support from those most valued and positive modelling of behaviour by those we respect. The authors report that the specific characteristics of groups, communities and whole populations that influence health behaviours are not clearly understood. They report that many studies make reference to the importance of social norms and culture with regards to health behaviours but that such phenomenon are difficult to quantify. By digging deeper into the concept of culture and social norms, Maibach and colleagues suggest that social capital, perceived social cohesion and a sense of collective efficacy have an important role to play.

The authors stressed that the people and places 'framework' is indeed a framework of public health rather than a theory or a theoretical framework for research purposes. Therefore, this theory is not used as a theory to be tested in this thesis, it is presented here as a suggestion of how to construct or think about public health interventions. In this thesis the ecological approach (rather than the 'people and places' framework) is utilised to guide interpretation of the findings.

2.1.1 Application of theory in this thesis

The ecological approach will be kept in mind upon interpretation of the results chapters and will be considered when exploring future research avenues. This is in line with Painter and colleagues' (2008) findings that in the majority of research cases where theory is used (69%) it is used only as a framework to guide the research.

An important element of the ecological approach to behaviour change is the influence of environmental and policy level factors. Following the implementation of SFL in England a number of evaluations were commissioned in order to assess the impact of the legislation not only on individual behaviour change but also on the health benefits associated with these changes. They will be discussed next.

2.2 Impact of SFL in England

Prior to the SFL in England, the Department of Health wanted to assess the impact of SFL on the following key outcomes (Bauld, 2011):

1. **Compliance**: Air quality in indoor public places and the health of bar staff
2. **Health**: Health outcomes in the general population and smoking prevalence estimates
3. **Population Experience**: Public attitudes towards SFL, smoking behaviours and quitting
4. **Business**: Hospitality sector (patronage, sales)

The principle aim of the SFL was to reduce the level of SHSe among non-smokers in the workplace and in indoor public places. It is possible to measure the achievement of this aim relatively easily by measuring compliance rates, and more importantly, cotinine levels of non-smokers in the workplace and air quality in public places such as pubs and clubs. Of course individuals may also be exposed at home if they live with smokers; therefore it was important to distinguish between workers with other sources of SHSe and those who only used to be exposed in indoor public settings.

All other impacts of the SFL are technically 'unintended', for example, any observed changes in people's smoking related knowledge and attitudes towards smoking cannot be directly attributed to the legislation in the way that air quality in pubs and decreased exposures of hospitality workers can be. As child SHSe is the main focus of this thesis, the impacts of the SFL in other areas will only be briefly summarised here. Most of the literature discussed in this chapter refers specifically to England. However, where appropriate, some international literature has been used to support certain findings; such incidences are clearly signposted throughout.

2.2.1 Compliance with SFL and improvements in air quality

In 2009, the International Agency for Cancer Prevention (IARC) reviewed the international evidence of the impacts of SFL (IARC, 2009). They concluded that levels of compliance in countries with comprehensive SFL are very high. The Department for Health one year review of SFL in England reported that the level of compliance with SFL has been consistently high since day one, with 98% of all public indoor premises and vehicles inspected between July 2007 and March 2008 found to be smoke-free (Department of Health, 2008; RCP, 2010).

2.2.2 Changes in attitudes towards SFL

In a longitudinal qualitative study that assessed, amongst other things, people's attitudes towards SFL in England, there were shifts in attitudes over time from resentment in the first instance before SFL was enacted in England, to gradual acceptance and general anticipation of the positive effects that the legislation may bring for personal smoking, health and a more pleasant social environment (Platt et al., 2009). Two reviews have found the same pattern in other countries implementing SFL (Callinan, et al., 2010; IARC, 2009).

2.2.3 Smoking prevalence

There was no significant decrease in adult smoking prevalence in England post-SFL (Table 1). Lee, Glantz and Millet (2011) investigated secular trends in smoking prevalence and consumption in England between 2003 and 2008. During these two time periods smoking prevalence reduced significantly from 25% to 21% as did cigarette consumption from 14.1 cigarettes to 13.1 cigarettes. However, after adjusting for trends over time, the SFL did not produce any additional reductions in prevalence or consumption (Lee et al., 2011).

There is some qualitative evidence to suggest that cigarette consumption decreased following the legislation in England (Lock et al., 2010; Platt, et al., 2009). The authors suggest that reductions in consumption may be unintentional and more an issue of compliance with the legislation during working hours. Qualitative evidence suggests that reduced consumption only refers to working hours, with disadvantaged mothers in Robinson and Kirkcaldy's (2007a) study reporting that reduced consumption at work is juxtaposed with compensatory heavy smoking when not at work. However, a more recent qualitative study with 32 smokers in London, found that half of the respondents reported smoking less since the introduction of the legislation, but that consumption varied greatly by ethnicity, age and gender (Lock, et al., 2010). Whilst half of respondents reported implementing smoke-free homes following the SFL in England, the majority of these respondents were Somali or Turkish. White respondents actually reported increases in home smoking behaviour. However, this was a small scale study in an ethnically diverse population in Islington, London and therefore these findings cannot be generalised to the population.

2.2.4 Health impacts (Children)

2.2.4.1. Respiratory

A recent post-legislation study conducted in Scotland concluded that there was a significant reduction in hospital admissions for asthma amongst children under the age of 15 following the ban (Mackay, Haw, Ayers, Fischbacher, & Pell, 2010). Analysis was adjusted for age, sex, socio-economic status, whether children resided in an urban or a rural dwelling and in which month and year the survey data was collected. Between 2000 and 2006, (before the legislation was implemented in Scotland in 2006) admissions for childhood asthma increased by an average of 5.2% (95% confidence interval 3.9-6.6%) each year. Post-SFL there was an 18.2% reduction relative to the rate of admissions in March 2006. The authors reported that it remained unclear whether the reductions in the incidence of childhood asthma admission was a result of the legislation preventing the exacerbation of asthma exacerbation altogether or whether exacerbations were of a lesser magnitude that did not therefore require hospitalisation. It is probable that the reduction observed is a consequence of both of these factors.

This Scottish study supports earlier findings of a subnational evaluation of smoke-free laws in Lexington-Fayette County in Kentucky in the US which found that adult admissions for asthma in four hospitals in the county decreased by 15% (95% CI 5%-24%) following SFL (Rayens et al., 2008). The County went smoke-free in April 2004. The regression analysis adjusted for seasonality, secular trends over time (Jan 2001-Dec 2006) and differences in different demographic subgroups. This study also looked at the asthma hospital admission rates for children aged 19 and under. Taking the trend in admissions for all previous years (2001-2004) into account there was a significant impact of the legislation amongst this age group with an 18% (95% CI 4%- 29%) decline in hospital admission rates for asthma. However, there was a marked increase in admissions between 2001 and 2002 that may have been having a biasing influence on the secular trend. When the data for 2001 was removed, there was no longer a significant impact of the legislation on children's admission rates. However, it could be argued that children 19 and under do not represent a homogenous group in terms of their likely SHSe. Older teenagers' sources and levels of exposure to SHS are likely to be quite different to those of younger children and therefore it might have been better to stratify this 'child' group.

More recently in the US, a population survey was utilised to assess self-reported changes in childhood asthma prevalence, incidence of symptoms and hospitalisation of those aged between 3 and 15 years (Dove, Dockery, & Connolly, 2011). Logistic regression analyses found that smoke-free laws in area of residence were not related to a decrease in asthma prevalence, however SFL was significantly associated with lower odds of asthmatic symptoms (Odds Ratio: 0.67, 95% CI 0.48-0.93) among non-smoking children. The direction of the relationship between SFL and emergency hospital attendances suggested that the SFL reduced such incidences but this relationship was not statistically significant.

In summary, there is some convincing evidence that SFL can improve the quality of life of children with asthma by reducing the severity of their symptoms. There are no known studies to date which assess the impact of SFL on other SHS-related illnesses such as SIDS.

2.2.5 Second-hand smoke exposure

It is not completely possible to accurately discern every source of children's SHSe. However, it is known that most of children's SHSe occurs in the home, this is especially true of younger children (Ashley & Ferrence, 1998; WHO, 1999; Wipfli et al., 2008).

SHSe has been measured in different countries, either through self-reported exposure, biologically validated exposure, air quality studies or a combination of these. Self-reported SHSe usually involves respondents indicating whether or not smoking occurs within their homes ('yes' or 'no' or 'sometimes') with some studies attempting to quantify this exposure (e.g. by asking about the number of hours exposed), whilst biologically validated measures of SHSe involve saliva or other biological samples (blood/hair) measuring the nicotine metabolite, cotinine. Self-reported estimates of SHSe amongst adults have been found to correlate reasonably with objective biological measures (Wong et al., 2002), whilst parental self-reported exposure of their children has been found to be significantly moderately correlated with children's urine cotinine levels and home air nicotine concentrations (Hovell et al., 2009). Therefore, self-reported measures of children's SHSe by parent smokers can be used as a relatively reliable measure of child SHSe.

As we know, the aim of the SFL was to reduce SHSe in indoor public places and workplaces and therefore, any reductions in SHSe in the home would be an unintended but welcome effect of the legislation. SHSe in the home was used as a counter argument to SFL as

concerns were expressed that SHSe in the home would increase as a result of prohibiting smoking in indoor public places. The then health secretary, John Reid, publically voiced this concern in 2005 (RCP, 2010).

Therefore, a number of studies were conducted in order to refute this claim. Most studies have used a before-and-after design to evaluate the impact of SFL on children's SHSe in the home, taking a time period before the legislation came into force and comparing it with a period after the legislation was enacted, typically one year apart (Akhtar, Currie, Currie, & Haw, 2007; Haw & Gruer, 2007; Health Promotion Agency for Northern Ireland, 2009; Holliday, Moore, & Moore, 2009). Such studies, however, are unable to account for underlying secular trends in exposure therefore, more recent studies evaluating the impact of the SFL in England, decided to look at trends in SHSe over a longer period of time and control for these trends when evaluating the impact of the legislation (Jarvis, et al., 2009; Jarvis, Sims, Gilmore, & Mindell, 2011; Sims et al., 2011; Sims et al., 2010).

In the following sections, a distinction will be made between before- and after-studies and trends studies of SHSe. Study findings from self-reported and biologically validated SHSe measures will be considered alongside each other.

2.2.5.1. Before-after studies

Despite a relatively short evaluation period, overall there was a significant decline in geometric mean cotinine in non-smoking children in Scotland between January 2006 (two months pre-SFL) and January 2007 (ten months post-SFL) from 0.36ng/ml (95% CI 0.32-0.40ng/ml) to 0.22ng/ml (95% CI 0.19-0.25ng/ml), a 39% absolute reduction (Akhtar, et al., 2007). SHSe was highest amongst those children with two smoking parents, closely followed by those with smoking mothers, then smoking fathers. Exposure was lowest in those children with no smoking parents. Although there was a significant decline in exposure overall, these declines were significant only for those children who either lived with non-smoking parents, or lived in a home where only their father smoked. As a distinction was not made between parents who smoked in the home and those who did not, it is likely to be the case that the reduction in cotinine for children with smoking fathers' represents a change in where smoking fathers are smoking, or that as children with smoking fathers were relatively little exposed it could be that for these children, a reduction in exposure in public places is responsible.

In Wales the SFL was implemented on the 2nd April 2007. Pre-legislation data was collected between 31st January and 30th March 2007 and post-legislation data were collected between the 31st January and the 28th April 2008 (Holliday, et al., 2009). There was no significant difference between pre- and post-legislation children's geometric mean cotinine levels when both parents smoked, just the mother smoked, just the father smoked or neither parent smoked inside the home. However, when children's exposure was categorised into low (<0.10ng/ml), medium (95% CI 0.10-0.50ng/ml) and high (>0.50ng/ml) exposure, there was a decrease in the proportion of children with high exposure from 30% to 28%, a decrease in medium exposure from 25% to 21% and a significant increase in low exposure from 45% to nearly 51%. Therefore, the observed decline in SHSe was confined to those whose cotinine concentrations were already relatively low pre-legislation. Howeverk in the low exposure category, only those children living with non-smoking parents and a smoking father only increased significantly from pre-legislation to post-legislation. This increase was not mirrored by those with a smoking mother or two smoking parents. Nevertheless, Holliday et al (2009) were able to conclude that contrary to concerns, the implementation of SFL in Wales did not increase the SHSe of children aged 10-11.

Despite these relatively small changes in SHSe indexed by cotinine, analysis of the self-report data revealed that significantly fewer children reported having parent figures who smoked in the home post-legislation. The proportion of children reporting that neither parent smoked in the home increased from 63% to 67% with a concurrent decrease in the proportion of children reporting that both parents smoking in the home from 17% to 13%. However, one would expect that decreases in self-reported exposure would be mirrored in concurrent decreases in cotinine but this is not the case in this study. This suggests some incidences of false reporting.

In accordance with the Welsh study and in contrast to the Scottish study, the Northern Ireland (NI) evaluation of SFL assessed geometric mean cotinine levels for children with smoking parents who smoked in the home (HPA, 2009). Children with a smoking father, who smoked in the home, had a geometric mean cotinine concentration of 0.45ng/ml pre- and 0.40ng/ml post-legislation. Interestingly, and in contrast to Scotland and Wales, cotinine concentrations actually increased following the legislation when a mother figure smoked indoors, from 0.95ng/ml in 2007 to 1.06ng/ml in 2008, and when both parents smoked in the home, from 1.46ng/ml pre-, to 1.73ng/ml post-legislation. However, it cannot be concluded that there was a displacement of smoking from public to private

places in NI following the SFL as these increases were not statistically significant. Therefore the authors concluded that their findings were in line with those in Wales and Scotland; there was no detrimental impact of the legislation in NI.

Both Holliday and colleagues in Wales and the Health Promotion Agency in NI suspected that the overall non-significant declines in cotinine in their studies compared to the significant overall decline in Scotland might have been due to floor effects associated with lower pre-legislation cotinine in Wales (0.17ng/ml) and NI (0.17ng/ml) compared to Scotland (0.30ng/ml). Differences cannot be attributed to differences in sample sizes as all were relatively similar in each study.

From these before-and-after studies it is difficult to conclude that the legislation had a downward effect on smoking in the home. However, the fact that tobacco control initiatives had significant media presence since *Smoking Kills* in 1998 via discussion, debate and implementation of a number of interventions, especially in the years and months preceding the SFL, cannot be overlooked. In all three studies discussed above, the data used were not routinely collected. Surveys were set up specifically to evaluate the impact of SFL as part of the changes in Children's Exposure to Environmental Tobacco Smoke (CHETS) study and so these studies could not have looked at trends over previous years as the data were not available. It may be the case that the apparent lack of decline in SHSe in Wales and Northern Ireland are due, at least in part, to pre-existing downward trends in SHSe, owing both to decreases in exposure in public places and the home over time. Before-and-after studies are useful, when interventions are likely to have an immediate impact or require a swift evaluation for political reasons (in this case it was necessary for public opinion to be able to refute the tobacco industry fuelled concerns that smoking in the home would increase as a direct result of the SFL), but the use of routinely available data allows researchers to take into account changes that have been occurring over a longer time period (Hovell & Hughes, 2009; Hovell, et al., 2011), such that adult smoking prevalence decreased over time in England together with significant changes in the tobacco control policy climate and that routinely conducted national surveys collected smoking related data, evaluations of the impact of the SFL on children's SHSe in England were trends studies.

2.2.5.2. Trend study results

In England, there are three studies that have looked at trends in children's SHSe; all utilised the nationally representative routinely available dataset, the Health Survey for England

(HSE) which collects smoking information for individuals within households, including cotinine (described in detail in chapter 4).

To explore levels and patterns of children's SHSe prior to the implementation of the SFL in England, Sims et al (2010) explored the trends in children's SHSe between 1996 and 2006 (with and without smoking parents). They found that amongst children aged 4 to 15, geometric mean cotinine declined by 59% from 0.59ng/ml in 1996 to 0.24ng/ml in 2006. Children's geometric mean cotinine in England in 2006 was almost identical to that found in post-legislation Scotland in 2006/7.

Children's SHSe according to parental smoking status was explored. For those children who had two smoking parents, their geometric mean cotinine fell by an average of 0.115ng/ml each year from 1996, whilst the geometric mean cotinine of those whose mother smoked fell by approximately half that amount each year (0.065ng/ml). In 2006 geometric mean cotinine levels were 1.70ng/ml and 1.50ng/ml, respectively. The biggest declines occurred in 2005 and 2006 when SFL was regularly debated in the media. The annual decline for children with non-smoking parents was much less (0.019ng/ml), settling at 0.50ng/ml in 2006. In households that allowed smoking indoors the median cotinine level in children from declined by 0.042ng/ml per year from 1996 to 1.70ng/ml in 2006. The decline in exposure was greatest in children who were most exposed, the authors therefore concluded that in absolute terms inequalities in SHSe have reduced. This is in contrast to the findings in other UK countries who found the largest declines in cotinine amongst those who were least exposed at the outset. These declines amongst the most exposed may be due to changes in parental smoking behaviour which may include quitting, cutting down and smoking less in the home or may be a result of societal changes whereby increasing numbers of indoor public places such as leisure facilities and family friendly restaurants went smoke-free prior to the legislation.

Nevertheless, in all cases, children with smoking parents were still the most exposed to SHS. The authors suggested that for those smokers who refuse to quit it is imperative to develop interventions that encourage smokers to smoke outdoors.

This was the first paper in England to examine trends in children's SHSe and how these trends varied by socio-demographic characteristics. Exposure was differentially associated with measures of social class, age, gender, ethnicity, home smoking behaviour and year. In

addition to parental smoking status, the other predictors of SHSe will be discussed in further detail in the determinants of SHSe in section later in this chapter. The remaining English studies discussed here include post-legislation data.

Jarvis et al (2009) examined the prevalence of smoke-free homes between 1996 and 2007 and explored the impact of a self-reported smoke-free home on children's geometric mean cotinine level. Between 1996 and 2007 smoke-free homes increased amongst non-smoking parent households (95%-99%), one parent smoker households (21%-37%) and two parent smoker households (6%-21%). The years preceding the SFL saw a surge in the proportion of smoke-free homes (Figure 6). The authors concluded that there was a 'marked secular trend' towards smoke-free homes even when parents themselves were smokers. This is compatible with the reductions in children's exposure found by Sims and colleagues (2010). Whilst encouraging, it was still the case that 79% of two parent smoker households were not smoke-free in 2007.

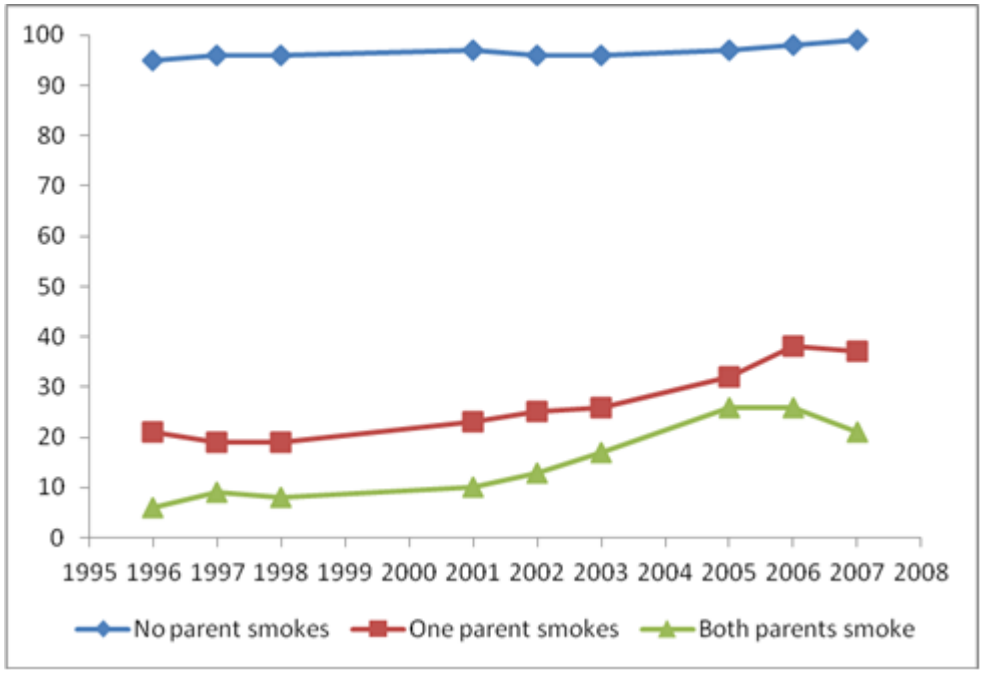

Figure 6 Percentage of children living in a smoke-free home by year and parental smoking habits

Source: Jarvis et al (2009)

In children with non-smoking parents, geometric mean cotinine declined from 0.29ng/ml in 1996 to 0.10ng/ml in 2007. In this study, the authors differentiated between children with smoke-free homes and those without. When all years were combined, children with at least

one smoking parent had geometric mean cotinine levels of 0.37ng/ml in smoke-free homes and 1.67ng/ml when smoking was permitted in the home. Those living with two smoking parents had cotinine levels of 0.70ng/ml and 2.46ng/ml respectively.

Cotinine levels also declined in *smoking households* over time from 1.81ng/ml in 1996 to 1.35ng/ml in 2007 in children with one smoking parent and from 2.85ng/ml to 2.18ng/ml in children with two smoking parents. This may suggest that parents are smoking less overall, that they are modifying their smoking behaviour to some extent, i.e. smoking in particular rooms only or not smoking when children are around, or that these children are less exposed in public places. This is an interesting observation requires unpicking.

In 2007, the HSE data was collected both pre- and post-legislation. However, as there was only 5 months of data post-legislation the authors cautioned that it was too early to comment on any potential impact of the legislation on the prevalence of smoke-free homes or children's geometric mean cotinine levels. This cautiousness is compatible with the philosophy of the ecological approach but in stark contrast to the methodology utilised by the before-and-after studies discussed earlier.

In follow up to Jarvis' 2009 paper, the explicit aim of Jarvis et al (2011) was to examine the impact of the SFL in England on children's SHSe. Once again trends in children's geometric mean cotinine over the preceding decade were observed. Taking into account previous downward trends, there was a non-significant decline in geometric mean cotinine in all children from 0.24ng/ml (95% CI 0.21-0.26ng/ml) in 2006 to 0.21ng/ml (95% CI 0.20-0.23ng/ml) in 2008. Amongst children with at least one smoking parent there was also a small non-significant decline from 0.82ng/ml (95% CI 0.70-0.97ng/ml) in 2006 to 0.77ng/ml (95% CI 0.67-0.87ng/ml) in 2008. In agreement with the before and after studies in Scotland, Wales and NI, the authors were able to conclude that the SFL did not cause a displacement of smoking into the home, reflected by the lack of increase in children's SHSe.

It is clear that there have been significant declines in SHSe in the past decade as indicated by decreased cotinine levels in children and increases in the number of smoke-free homes (Jarvis, et al., 2009; Jarvis, et al., 2011; Sims, et al., 2010). Post-SFL, significant reductions in children's SHSe were found in the before-and-after study conducted in Scotland (Akhtar, et al., 2007). It might be the case that exposure in these children decreased as a result of less exposure in public places rather than as a result of any changes in home smoking

behaviour, expecially as these were the children least exposed in the first place. However, no significant reductions in children's exposure were found post-SFL in any other UK study. This is likely to be because SHSe had already been in decline in the years preceding the legislation. It is unknown whether SHSe would have continued to decrease without the legislation providing continued momentum to the downward trend. In Scotland exposure seemed to be higher pre-SFL than in England, Wales or NI. In all of the studies children with two smoking parents were most exposed to SHS and were the least likely to live in a smoke-free environment. However, some of the evidence shows that the biggest absolute changes over the past decade have occurred for those children who were most exposed at the outset (Sims, et al., 2010). This may suggest that smoking parents are responding to changes in smoking culture by changing their indoor smoking behaviour to some extent, thereby reducing children's cotinine levels, or it may be the case that exposure has decreased due to less exposure in public. However, if this were the case one would expect to see similar declines in exposure across all child groups. In either case, these individuals still need further targeting as prevalence of smoking in the home is still highest amongst this group.

In addition to the UK research which explores the prevalence of children's SHSe, there is a large body of evidence which attempts to identify the pertinent characteristics associated with children's SHS exposure, a few of which have been discussed in this section, e.g. home smoking policy, parental smoking status, presence of a child in the home. Exploring the features most commonly associated with children's exposure to SHS in the home can help target those most exposed for further intervention especially if the most pertinent characteristics are those that can be easily changed, relatively speaking i.e. smoking status rather than gender or social class. Discussion of the factors that are associated with children's SHSe forms the subject of the next subsection of this chapter.

2.3 Determinants of children's SHSe

Although many studies in many different countries have looked at many determinants of childhood SHSe, each study does not include every possible determinant of exposure and the majority of studies have assessed the univariate relationship between each predictor and the outcome measure of SHSe (IARC, 2009). In the following section, the evidence is not confined to the UK, as is the case in the preceding trends section above, as it is evident that many of the important associations found in the UK are also found elsewhere in the

world. There is a rich body of international evidence that can be used to add strength to those relationships found in England. Although quantitative evidence using nationally representative routinely collected data can be more widely generalised to the population as a whole, there is also a place for a discussion of the qualitative evidence here which can be used to supplement the quantitative data and inform researchers, public health personnel and policy makers about key issues that are not easily captured in routine surveys, thus providing further insight into the complex motivating factors underlying smokers' behaviour in the home. Relevant relationships between socio-demographic factors and child SHSe as measured by self-report or biological samples will be discussed in turn. The focus will be on the children of smokers but there are some studies included in the discussion that also include non-smokers in the study sample.

2.3.1 Smoking in the home

We already know that children who live in homes where smoking occurs inside on most days have significantly greater cotinine concentrations than children who live in smoke-free homes (IARC 2009; Jarvis, et al., 2009; Jarvis, et al., 2011; Sims, et al., 2010) Therefore, if smokers were to make their homes smoke-free, they would significantly protect their children from the majority of their SHSe.

However, qualitative studies have shown that many smokers indicate that smoking rules are fluid and very much dependent on who is in the house at the time. For example, smoking restrictions were stricter in the presence of children but less so with other adults. Some mothers reported a smoke-free home but then also reported smoking regularly on the back step (unaware that this is not strictly outdoor smoking as the constituents of SHS escape back through the open door) and on occasion in the bathroom or in the kitchen and in their own bedrooms (Phillips, Amos, Ritchie, Cunningham-Burley, & Martin, 2007; J. Robinson & Kirkcaldy, 2007a).

If all homes that are reportedly smoke-free were in fact smoke-free then children's cotinine levels would be lower still in 'smoke-free' homes. Furthermore, it would be useful to understand the smoking behaviour of those smokers who do not live in a smoke-free home as it is this group that potentially requires the greatest level of intervention.

2.3.2 Smoking status

Although there have been increases in the prevalence of smoke-free homes amongst smokers, they are still more likely to allow smoking in the home than non-smokers (IARC, 2009; G. King, Mallett, Kozlowski, Bendel, & Nahata, 2005; Lund & Helgason, 2005; Martinez-Donate, Johnson-Kozlow, Hovell, & Gonzalez Perez, 2009; Shopland, Anderson, & Burns, 2006; Sims, et al., 2010). However, there have been significant developments in some countries where over half of smokers in New Zealand (Gillespie, Milne, & Wilson, 2005), Norway (Lund & Lindbak, 2007), California (Al-Delaimy et al., 2008) and Finland (IARC, 2009) no longer smoke in their homes.

In homes with smokers, children's SHSe varies with the number of parents that smoke, with children who live with two parent smokers having cotinine concentrations higher than those living with only one smoker in the household (Jarvis, et al., 2009). This may be a result of a greater volume of smoke or may be reflective of fewer smoking restrictions when both parents smoke as each other's behaviour acts as validation to the other, promoting the social norm that smoking is acceptable.

When only one parent smokes, children's SHSe changes dependent on whether it is the mother or father that smokes. Those with smoking fathers only tend to be significantly less exposed to the tobacco smoke in comparison to when their mother is the sole smoker (Akhtar, et al., 2007; Peltzer, 2011; Sims, et al., 2010). This is perhaps reflective of the typical gendered nature of child care roles between parents, with mothers being more likely to spend significantly more time with children in the home than the father.

2.3.3 Policies that affect smoking in the home

Wider tobacco control policies can over time affect exposure even if the evidence of SFL having an impact in the short term is limited. For example, despite UK findings showing little impact of the SFL on children's SHSe other than in Scotland (Akhtar et al., 2007), comprehensive tobacco control programmes (of which SFL is an important constituent) are likely to be important in changing social norms about where it is appropriate for smokers to smoke (Thomson, Wilson, & Howden-Chapman, 2006). Callinan, Clarke et al (2010) reviewed 15 studies that measured home smoking behaviours. Three of these studies reported some reduction in SHSe in the home following the legislation in New Zealand

(Waa & McGough, 2006), Ireland (Fong et al., 2006) and California (Gilpin & Pierce, 2002). The rest of the studies were conducted in several different US states, Spain, Sweden and Scotland and found no significant change in home exposure, but importantly no significant increase either.

These findings support the tenets of ecological theory which proposes that population level interventions take time to affect the behaviour of individuals within the population as attitudes and beliefs need to change first as well as the social norms of groups. However, the ecological approach does also highlight that some groups may be more malleable than others and so changes may occur more rapidly in such cases (Sallis & Owen, 2008).

Trends in smoke-free homes have increased over time commensurate with changes in tobacco control policy and social norms in the UK (Jarvis, et al., 2009; Jarvis, et al., 2011; Sims, et al., 2010). It is likely that places that are relatively advanced in their tobacco control agenda, (i.e. they have taken many measures aimed at reducing smoking prevalence and SHSe over time) have witnessed concurrent increases in SHS-protective behaviours over time before the implementation of the SFL (Borland, Mullins, Trotter, & White, 1999; Centers for Disease Control and Prevention (CDC), 2007; Lund & Lindbak, 2007; Sims, et al., 2010) and that these trends continue following SFL (Akhtar, et al., 2007; Fong, et al., 2006; Health Promotion Agency for Northern Ireland, 2009; Holliday, et al., 2009; Jarvis, et al., 2009; Jarvis, et al., 2011). International support for the impact of comprehensive tobacco control programs on the prevalence of smoke-free homes comes from the California Tobacco Control Program (CTCP). This program has been running for over two decades and like England this program has evolved over time to include SFL in public places and workplaces, high tobacco product taxation, advertising and promotion bans, cessation services and mass media campaigns. In San Diego, where exposure to the CTCP is very high, the prevalence of smoke-free homes amongst Mexicans and Mexican Americans was 90.7% in 2004, this is in comparison to 66.2% amongst those in Tijuana which is on the border between California and Mexico and is partially exposed to the CTCP, and 39.0% in Guadalajara which is 1188 miles away from San Diego and much less exposed to the effects of the CTCP (Martinez-Donate, et al., 2009). This supports the argument that comprehensive tobacco control policies increase the prevalence of smoke-free homes. Similarly in a national US study, researchers found that individuals living with a smoker in a county with a comprehensive ban on smoking in indoor public places was strongly positively associated with having a smoke-free home (OR 7.76, 95% CI 5.27-11.43)

compared with individuals living in a county without such restrictions (Cheng, Glantz, & Lightwood, 2011). Stark differences between counties with and without legislation in the US may be indicative of the absence of a culture of increasing tobacco control in those counties without SFL. This is also supported by the four country survey of Australia, the US, the UK and Canada conducted in 2002/3 which found that areas with legislative smoking restrictions in bars and restaurants were more likely to have a higher proportion of smoke-free homes (Borland et al., 2006). The implicit assumption is that further policies that continue to denormalise smoking will carry on the downward trend of children's SHSe in the home.

However, qualitative data from regional studies suggests that at the individual level, smokers do not perceive that the SFL has had any impact on their smoking behaviour in the home (Phillips, et al., 2007). Following the legislation in Scotland, qualitative work reported that many smokers who smoked in the home before the SFL continued to do so and a small number of women reported increases in home smoking due to the change in social environments. Women who did not work and who were the main caregiver for their children were more likely to smoke in the home and more likely to spend time socialising in other smokers' homes than in public places. When in paid employment women reported smoking much less. Interestingly, women reported being able to go for long periods of time without smoking when in a public place or workplace because of the legislation. They saw this as a positive but subsequently used SFL as a rationale for smoking in their own homes because they were not able to do it in indoor public places. Boredom and 'because you can' were cited as reasons for smoking in the home amongst women. Therefore, women's public smoking behaviour changed as a result of the legislation but their home smoking behaviour did not. This study provides valuable insight into the world of smokers with caring responsibilities. However, this information is only based on 30 individuals who smoke in the home in deprived areas and is therefore not generalisable to the entire population of smoking mothers.

In addition to the key factors such as smoking in the home and smoking status of parents, children's SHSe is associated with a range of factors at three main levels – individual, household, and area. In this case individual factors refer to the characteristics associated with each child, i.e. age, gender and ethnicity of the child and not the individual characteristics of the smoker which have been discussed in some of the earlier literature in this chapter. Household factors are all those factors that are common to the household, for

example, social class, highest level of education in the household, the type of house lived in, the presence of children in the household, number of smokers in the household and many more. Many of these variables are likely to be correlated with one another, which provides a case for producing multivariate adjusted models of the determinants of SHSe. In the literature it is largely the relationship of SHSe with household factors that are explored in detail. However, it may be the case that where a child resides geographically has an impact on children's level of exposure, or whether a child lives in a predominantly urban or rural environment. The contribution of each of these factors will be considered in turn.

Child level factors

2.3.4 Age group

In 1992/3, there was little difference in the prevalence of smoke-free homes in the US dependent on the age of the youngest child in the household but by 2006/7 this had changed (Hawkins & Berkman, 2011; Mills, White, Pierce, & Messer, 2011). Homes were much more likely to be smoke-free if children under the age of 6 lived there compared to those aged over 14 years (58.7%, 95% CI 56.0-61.3% compared to 40.3%, 95% CI 36.4-44.1%, respectively). These differences remained when stratified by parental ethnicity and education. This suggests that a social norm has been created whereby the exposure of infants is considered inappropriate. It is likely that this is a result of mass media emphasising the protection of young children from the harmful effects of SHS, but that this has unintentionally led parents to believe that older children are not at so much risk.

However, in England, Sims et al (2010) found that with every year increase in age of 4-15 year olds geometric mean cotinine declined by 2.5% (95% CI 1.8-3.1). This may be indicative of the decreased dependency of children on their parents as they get older, i.e. they do not spend as much time in the home or in close proximity to smoking parents in comparison to younger children. Unfortunately, Sims' study did not include infants under the age of four as they are not required to give a saliva sample in the HSE. It is possible that the relationship between child age and cotinine concentrations would no longer be linear if younger children provided saliva samples. If the aforementioned study is correct then younger children might be expected to have lower exposure and this may rise after children progress from infancy before declining once more as children become more independent. This relationship requires clarification.

2.3.5 Gender

None of the studies reviewed found that the gender of the child significantly predicted whether or not they were exposed to tobacco smoke in the home.

2.3.6 Ethnicity

According to research in both England and the US, White children appear to be the most at risk of SHSe. In England between 1996 and 2006, White children had cotinine concentrations that were significantly higher than the cotinine concentrations of Black or Asian children (Sims, et al., 2010). A potential explanation for this could be that smoking prevalence is lower amongst Black and Asian adults in England or that Black or Asian smoking parents are more likely to take their smoking outdoors rather than smoke inside the home.

A similar pattern was found in the US in 2008, in a more detailed consideration of the relationship between ethnicity and SHSe. Non-Hispanic White (32.8%, 95% CI 27.8-37.8%) and African American (48.0%, 95% CI 46.1-49.9%) children of smokers were less likely to have a smoke-free home in comparison to Asian/Pacific Islander (65.9%, 95% CI 55.2-76.7%) or Hispanic (72.2%, 95% CI 67.5-76.8%) children. However, smoke-free home prevalence by ethnicity was highly correlated with smoking prevalence for that ethnic group in each state (Mills, et al., 2011). For example, smoke-free homes were higher amongst non-Hispanic Whites when smoking prevalence amongst this group was lowest. The lowest smoking prevalence (12.5%) and subsequent highest smoke-free home prevalence (80%) was in Utah with the lowest prevalence of smoke-free homes (<30%) in West Virginia where smoking prevalence amongst this group was high (25.5%). The same relationship was found for Pacific Islanders and Hispanics. This suggests that social norms are occurring at state level for these groups and that smoking behaviour is not ethnic group specific it is state prevalence specific, however, for African American children, smoke-free home prevalence remained around 50% regardless of the state-wide smoking prevalence for this group suggesting that a separate cultural influence may be having an impact here.

In addition to these child level factors there are several factors that are measurable at the household level and have been found to be associated with childhood SHSe. Some of these

factors are interpersonal factors whilst others are socio-demographic and others related to the behaviour of parents within the household.

Household factors

2.3.7 Presence of children in the home

As aforementioned, the presence of children in the home is associated with a higher prevalence of smoke-free homes (Borland, et al., 1999; Gilpin, White, Farkas, & Pierce, 1999; IARC, 2009; Okah, Choi, Okuyemi, & Ahluwalia, 2002; Okah et al., 2003; Pierce et al., 1998) particularly a young child (Berg et al., 2006; Borland, et al., 2006; Martinez-Donate, et al., 2009; Merom & Rissel, 2001; Pizacani et al., 2003; Shopland, et al., 2006). The qualitative evidence suggests that concern about the negative impact on children's health and more commonly concern about role modelling negative behaviour promote SHS-protective behaviours (Escoffery, Kegler, & Butler, 2009; Jones et al., 2011; Phillips, et al., 2007). The importance of the presence of children as a motivator for SHS-protective behaviour is highlighted by the fact that smokers who lived on their own or with other smokers were the least likely to report having any smoking restrictions in the home (Phillips, et al., 2007). However, although smoke-free homes are more likely in households with children, smokers without children are still more likely to refrain from smoking in the presence of a child (Dunn et al., 2008). This contradictory information suggests than although smokers who do not have children are less likely to have smoke-free homes that those with children, they find it easier to refrain around children. This is likely to be because they are in the presence of children less often than parents, who live with their children, are.

2.3.8 Where in the home does smoking occur

Blackburn et al (2003) concluded that only a total ban on smoking in the home could protect children from SHS as they found no difference in infants' mean log urinary cotinine to creatinine ratios between parents who took 'protective' measures in the home and parents who smoked everywhere in the house. However, the authors grouped together protective behaviours such as: 'do not smoke in the same room as a child', 'do not allow smoking in the living room', 'do not allow smoking where the child sleeps or naps', 'air the room when someone smokes' and 'air the room after someone smokes'. They conceded that this made it difficult to determine the independent efficacy of each of these measures.

It is possible that some of these measures are more effective than others and so further research should look at the unique relationship of each measure with child SHSe.

In Australia, Wakefield et al (2000) found that parents limiting their smoking to rooms in the home that children rarely frequented led to significantly lower urinary cotinine to creatinine ratios (14.1nmol/mmol) in comparison to parents who allowed unrestricted smoking in the home (26.0nmol/mmol). Nevertheless, it should still be noted that implementing a smoke-free home is the most effective way to protect children from SHSe (7.6nmol/mmol). Similarly, in Sweden, Johansson, Hermansson and Ludvigsson (2004) found a significant difference in urine to creatinine ratios between those children whose parents reported smoking in an open external doorway as well as smoking outside the home compared to those who smoked indoors. The same was true of smokers who smoked next to a kitchen extractor fan in addition to smoking outdoors. However, when parents used a combination of protective behaviours such as smoking next to the kitchen extractor fan, smoking outside and smoking in an external door way there was no significant difference between these behaviours and smoking indoors.

These inconsistent results may be partly to blame for the conflicting evidence presented to the public and the resulting confusion amongst parents and therefore it would be useful to have definitive evidence of the efficacy of different measures that parents take in the belief that it reduces the level of SHS in the home.

2.3.9 Socioeconomic position (SEP)

Those children living in households of lower social class are more likely to be exposed to SHS, live with a smoker and are less likely to live in a smoke-free home compared to those of higher social class (Bolte & Fromme, 2008; IARC, 2009; K. King et al., 2009; Mills, et al., 2011; Phillips, et al., 2007; Shopland, et al., 2006). In England, adjusting for other predictive variables of child SHSe including parental smoking status and existence of smoking in the home, those children living in households where the highest parental occupation was either part-skilled or unskilled had geometric mean cotinine levels that were 1.3 times higher than those children where the highest parental occupation was managerial or professional (Sims, et al., 2010). Similarly, children with parents who were unemployed compared to those with parents in employment were 1.3 times more likely to be exposed to SHS. Children's cotinine concentrations were 1.5 times higher when their parents' highest level of

qualification was no qualifications compared to those children whose parents' highest qualification was a degree or equivalent. Sims reported an absolute reduction in inequalities in 2006 with the largest absolute increase in smoke-free homes observed in those who were most exposed at the outset in 1996. Given that the most exposed were also the most deprived, the most deprived group improved significantly. However, in relative terms inequalities have not reduced (RCP, 2010). This is in accordance with other studies which have not found a reduction in inequalities in SHSe over time. For example, a further evaluation of the Scottish SFL focused on social inequalities in SHSe amongst primary school children (Akhtar et al., 2010). The highest child cotinine concentrations were found amongst the least affluent and lowest amongst those most affluent. Although the largest absolute reduction in cotinine post-legislation was highest for those of lowest SEP, cotinine levels were still the highest in this group and when relative change was considered over time, the results suggested that inequalities have not in fact reduced between 2006 and 2007.

In Wales, just over 50% of children from low socio-economic status (SES) households reported living with a parent figure who smoked in the home both pre and post-SFL (Moore, Holliday, & Moore, 2011). In comparison 27.6% of those of high SES lived in a smoking household pre-SFL declining to 21.9% post-SFL; a decline approaching statistical significance. Following the SFL children from the lowest SES households were approximately 2.5 times more likely to live with a parent who smoked in the home compared to those of higher SES. In short, the SFL in Scotland and Wales appears to have had a differential impact in different SES groups.

Although it is not easily possible to modify one's SES, Borland, Yong et al (2006) were encouraged that the lower levels of smoke-free homes amongst those of lower social class were mediated by levels of addiction and a pro-smoking environment, as these are modifiable factors that well targeted interventions may be able to address.

Qualitative research support Borland's findings of a pro-smoking environment as one mechanism underlying the higher prevalence of smoking in the home amongst the most disadvantaged groups. The social norms of this group which are reinforced by the high level of smoking prevalence amongst disadvantaged smokers leads this group to perceive smoking as a normative social behaviour (Jones, et al., 2011) and this is an important factor that requires careful consideration in future interventions.

In 2000-2004 in the US, the Medical Expenditure Panel Survey found that children that lived in households with at least 3 adults were 2.21 times more likely to live with a smoker than those living with two adults (King et al, 2009). The presence of many adults in one household is often a sign of overcrowding. Overcrowding can be considered a proxy measure of social class.

2.3.10 Knowledge of the dangers of SHS

Knowledge acquisition is an important step in the process of health behaviour change (Farquhar, et al., 1984; Janz & Becker, 1984b; Klesges, et al., 1988; Nourjah, et al., 1994; Potvin, et al., 2000; Siahpush, et al., 2006; Stead, et al., 2001). Smokers' concern about the impact of their smoking on children's health has been cited as a motivating factor in implementing home smoking restrictions (Heck et al., 2010; IARC, 2009; Jones, et al., 2011; Kegler & Malcoe, 2002; Lund & Helgason, 2005; Phillips, et al., 2007; Pizacani, et al., 2003; Ponsonby, Couper, & Dwyer, 1996; Soliman, Pollack, & Warner, 2004; Yousey, 2006).

However, although knowledge of the impact of active smoking is thought to be widespread, and people are familiar with the term passive smoking, it is unclear whether people are truly aware of the dangers that SHS poses to non-smokers. Many studies suggest that respondents know that SHS is harmful but the majority of these studies do not require their respondents to quantifying this harm or list actual illnesses that can occur as a result of SHSe (Blackburn, et al., 2003; Heck, et al., 2010; Hopper & Craig, 2000; Kegler & Malcoe, 2002; Phillips, et al., 2007; Pizacani, et al., 2003).

For example, in qualitative research conducted with mothers in Merseyside in England (Robinson & Kirkcaldy, 2007b), the authors reported that mothers' knowledge of the danger that SHS posed to their children varied greatly, yet the study does not mention any specific illnesses discussed by the women. General terms about whether mothers knew smoking was harmful were utilised. Very few parents were able to link SHS with any specific illnesses and then the only illnesses identified were respiratory, i.e. asthma (Green, Courage, & Rushton, 2003; Jones, et al., 2011; Lund & Helgason, 2005). This is something that warrants further investigation. A US study compared respondents' knowledge of SHS-related illnesses dependent on whether they are asked using open-ended questions or closed-ended questions (Steil, Lorenzo, & Sydeman, 2010). Unsurprisingly, respondents

'knew' more when asked closed ended questions, suggesting that using closed ended questions may lead to an overestimation of smoking related knowledge. The authors concluded that future studies should utilise open ended questions in order to identify specific gaps in knowledge that can be addressed by future public health campaigns.

In Norway, knowledge of the specific health risks associated with SHSe increased between 1995 and 2001 for both smokers and non-smokers but knowledge was still poorest amongst smokers with 22% aware that SHSe can cause ear infections in children and 9% aware of the link with SIDS (Lund & Helgason, 2005). However, despite this poor level of knowledge better knowledge was positively associated with the prevalence of smoke-free homes, thus suggesting that if SHS-related knowledge was improved amongst smokers then potentially the prevalence of smoke-free homes might increase. In a qualitative Australian study, smokers that were told that SHS causes specific illnesses in non-smokers and children immediately indicated that they would amend their smoking behaviour in the presence of others (Dunn, et al., 2008), although this behaviour was not subsequently measured. Similarly, better knowledge, whether achieved using open ended or closed ended questions, was positively associated with attempts to reduce the SHSe of others (Steil, et al., 2010). However, in Steil's study the outcome measure was not smoke-free homes it was a composite measure of SHS avoidance behaviours and so it is likely that smokers in this sample were still exposing others to SHS in the home despite taking 'preventive efforts'.

In addition to knowledge of the specific illnesses that SHSe can cause, it is apparent that parents are unclear about whether opening windows or doors, limiting smoking to certain rooms or at times when children are not present are effective ways to eliminate the risk of harm to their children (Blackburn, et al., 2003; USDHHS, 2006). Hill et al (2003) asked respondents to rate the effectiveness of various strategies used to protect children from SHS between 0 and 10; (0 representing absolute ineffectiveness and 10, total effectiveness). Opening windows or doors had a mean rating of 5.6, smoking in a separate room was given 5.5 and smoking in the kitchen with the extractor fan on was given a 5.0. Therefore, smokers believe that their strategies do have some positive effect but they are equally sceptical that their methods offer complete protection. Similarly, in Scotland there was a palpable lack of clarity about which were the most effective methods to protect children from SHS (Robinson & Kirkcaldy, 2007b). Moreover, mothers reported knowing

about the link between SHS and coughs and asthma[5] but for most this information was distorted and pervaded by their experiences and lay perceptions of the causes of these illnesses. Rather than attribute childhood illnesses to their smoking behaviour, mothers tended to proffer alternative explanations such as the hereditary nature of conditions such as asthma, the role of air pollution in general and they compared the health of their own children to those of both smokers and non-smokers and concluded that if children of non-smokers also had coughs or asthma then it must be the case that the same conditions in their own children were not solely caused be their smoking. Mother's tendency to compare the health of their children with the health of other children living in their area is a well-known phenomenon (Blaxter, 1997), with social norms for the area in which you live likely to influence what one perceives as normal. Therefore, it is not surprising that those living in poorer areas report worse knowledge and greater acceptance of smoking as smoking prevalence is higher which presents smoking a normative behaviour. Once again, these findings support the use of the ecological approach when assessing the determinants of children's SHSe as environmental factors clearly exert an influence.

It is not just mothers who report that smoking does not cause illness; smokers in general report poorer knowledge than non-smokers (Green, et al., 2003). It is not necessarily the case that knowledge is genuinely poorer amongst smokers. Refuting the evidence or providing anecdotal evidence and alternative explanations for ill health in order to continue with a behaviour that is known to be harmful is an example of cognitive dissonance. Cognitive dissonance occurs when there is a discrepancy between an individuals' behaviour and their beliefs (Aronson, 1969; Festinger, 1957). To eliminate this dissonance and achieve consonance between one's behaviour and beliefs, one or the other must be changed. Amongst smokers who want to or 'need to' continue smoking changing the belief is easier than changing the behaviour and this is one reason why mothers may present alternative explanations for any ill health experienced by their children (Robinson & Kirkcaldy, 2007a). None of the mothers considered that there were any long-term impacts of SHS on children's health. They believed that future smoking-related heart disease and cancer would only potentially occur in children that went on to smoke themselves. In this study, few mothers conceded that their role modelling of smoking behaviour would have any impact on children's smoking in the future as once again they used anecdotal evidence of what occurred in their own families and their belief that they themselves started smoking

[5] In this study, mothers were not aware of any other illnesses associated with SHS.

as a result of their own free-will. Many displayed unrealistic optimism about their own chances of getting a smoking related illness and this was further translated to the health of their children. This confirms the findings of earlier studies where smokers generally accept that SHS is damaging to health but they display dissonance behaviours and unrealistic optimism about the risks which allows them to continue smoking and exposing others to their smoke (Chapman, Wong, & Smith, 1993; Weinstein, 1989, 2001).

The relationship between specific knowledge of the health impacts of SHSe and SHS-protective behaviours requires investigation. Mass media campaigns can be used to increase knowledge. Although such campaigns are expensive, if they have the potential to lead to eventual behaviour change then they can be viewed as a cost effective intervention, saving the NHS from spending on treatments for children with smoking related illnesses. The potential of mass media campaigns to make a difference to children's SHSe is discussed later in this chapter.

2.3.11 Level of addiction to smoking

The term addiction in this context refers to physiological nicotine dependence and also psychological/habitual addiction. A number of American cross-sectional studies assessing the determinants of home smoking restrictions have included variables related to heaviness of smoking occurring in the household such as daily cigarette consumption (Kegler & Malcoe, 2002) or level of addiction (Berg, et al., 2006). Odds of having a smoke-free home or any kind of smoking restriction in the home for those smoking more than 20 cigarettes per day or having a Fägerstrom Test of Nicotine Dependence (FTND) score of 6 or above were half those for smokers who smoked less than 20 per day and who were less addicted to nicotine (Berg, et al., 2006). The FTND produces a score between 1 and 10 based on scores derived from responses to 6 questions: 1) How soon after waking do you smoke? 2) Do you find it difficult to abstain from smoking in places where it is forbidden? 3) Which cigarette of the day would you hate to give up the most? 4) How many do you smoke per day? 5) Do you smoke more in the first hours after waking than the rest of the day? 6) Do you smoke even if you are so ill that you are in bed most of the day? (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991).

In 2008, a five country survey of smoking bans in Italy, Ireland, Sweden, France and the Czech Republic was conducted to assess the prevalence of smoke-free homes and the

characteristics of such homes (Heck, et al., 2010). In all five countries smoke-free homes were negatively related to levels of addiction.

Qualitative research highlights the role of addiction in home smoking behaviours but rather than nicotine dependence, smokers talk about the psychological dependence of smoking behaviour and how engrained the behaviour has become (L. Hill, et al., 2003; Jones, et al., 2011). This suggests that new proposals for harm reduction strategies such as reducing cigarette consumption may not only have health benefits for the smoker but may also have benefits for adult non-smokers and children who reside with smokers.

2.3.12 Outdoor space

In studies in England, Australia and the USA, the weather has been cited as a barrier to smoking outside. Poor weather conditions reportedly act as a deterrent to smoking outdoors with parents viewing the process of preparing a child to go outside in the rain as too much effort (Escoffery, et al., 2009; Jones, et al., 2011; Wakefield et al., 2000). Similarly, qualitative research found that those living in deprived areas reported that they desired to smoke indoors because it provided comfort and safety (L. Hill, et al., 2003; Jones, et al., 2011).

It is likely that the provision of outdoor space is highly correlated with SEP For example, in their German study of SHSe, Bolte and Fromme (2008) found that children were more frequently exposed to SHS when living in an apartment/high-rise building (crude univariate OR 2.41 (95% CI 2.22-2.61). However, this information was not presented in the final adjusted model which suggests that when adjusting for other factors, this relationship was explained away by another factor in the model. In qualitative studies, parents reported the lack of appropriate outdoor space as a real barrier to smoke-free homes (Halterman et al., 2007; L. Hill, et al., 2003; J. Robinson & Kirkcaldy, 2007a).

Hill et al's (2003) study focused on smokers who lived in an apartment with either a child or a non-smoker who was trying to get the smoker to protect others from SHS. They found that those with large gardens had less issues with smoking away from the home and away from their children, but that those with small gardens found it more difficult as their children would be in close proximity when they accompanied them outside and those only

able to smoke out front of the house would often report smoking in the open doorway as they wanted to prevent their children from running out and into the road.

The availability of appropriate outdoor space has not been quantitatively assessed in England. It is unclear whether lack of outdoor space is measuring the same variance as SEP or whether lack of outdoor space can be considered a mechanism of smoking indoors amongst lower SEP groups because it is more difficult to go outside.

2.3.13 Interpersonal issues

In the qualitative literature exploring the barriers and facilitators of smoking restrictions issues surrounding interpersonal relationships between smokers and other family members and friends continually arise (Green, et al., 2003; Jones, et al., 2011; Wakefield, et al., 2000). Firstly, in families with more than one smoker, the reinforcement of smoking norms is likely to occur. Second, in cases where one smoker would like to implement restrictions it has often been reported that they feel they lack the autonomy to enforce smoking restrictions with other smokers in the family and in many cases they are reluctant to offend others by broaching the subject of smoking abstinence indoors (Halterman, et al., 2007; L. Hill, et al., 2003; Jones, et al., 2011; Kegler, Escoffery, Groff, Butler, & Foreman, 2007; Phillips, et al., 2007; J. Robinson & Kirkcaldy, 2007a, 2007b; Wakefield, et al., 2000). Thirdly, smoking mothers living with smoking partners described how smoking rules had to be negotiated and that these rules were often difficult to enforce as their partners were non-compliant (Robinson & Kirkcaldy, 2007a). Interventions focused on empowerment, cohesion and negotiation may make such discussions more commonplace.

More recently, Robinson, Ritchie, Amos et al (2011) have considered the impact of home smoking restrictions on the smoking behaviours of wider family and social networks. The authors acknowledged that the social and cultural context of smoking has already been identified as important (Chapman & Freeman, 2008; Poland et al, 2006) but that family politics haven't been explored enough. They concluded that home smoking behaviour has been gradually modified over the years in three key ways:

1. Imperceptible changes in home smoking behaviour which have evolved through voluntary decisions potentially as a result of internalising the evolving social norm

that children should be protected from tobacco smoke. In this scenario change is devoid of any family conflict.

2. Changes which have involved negotiated decisions where changes were discussed and negotiated with family and friends
3. Changes which have occurred as a result of enforced decision making process where one member of a family imposed smoking rules with threat of sanction for non-compliance.

This study found that restrictions in home smoking were not made only by smokers with children living in the home but also by grandparents and smokers who did not live with children. This is in accordance with Borland et al (1999) who found that smokers who sometimes spent time with children were likely to positively change their smoking behaviour around children. Robinson et al (2011) found that changes to smoking behaviour may occur naturally due to changing culture and context alone or they may change through additional discussion and conflicts between family members. They argue that the household should be conceptualised as the people living there and these people should be considered with regards to their wider family and social roles within which smoking behaviour attitudes can be spread.

2.3.14 Caring duties

The competing needs of smoking parents is another frequently cited barrier to implementing a smoke-free home, with smokers' need to smoke often in conflict with their need to supervise young children (Borland, et al., 1999; Green, et al., 2003). Mothers were concerned about leaving their children unattended in the home if they were to go and smoke outside or in another room, with many parents concluding that smoking poses less immediate risk than leaving children unattended (Halterman, et al., 2007; L. Hill, et al., 2003; Jones, et al., 2011).

Also, in cases where mothers did attempt to smoke away from their children some reported that the children followed them wherever they went and they were afraid of the emotional consequences of telling the children to not follow them. Furthermore, this conflict can help explain why smokers without children find it easier to abstain in the presence of children than smoking parents (Dunn, et al., 2008).

2.3.15 Aesthetics

Two qualitative studies, one in a disadvantaged area in Nottingham, England and one in Scotland found that a major consideration of smoking parents was the negative aesthetic impact of indoor smoking, with many reporting counter-behaviours to combat this, such as opening windows and doors, lighting candles and spraying air freshener (Jones, et al., 2011; Phillips, et al., 2007). In Jones and colleagues' study in Nottingham, aesthetic motivations were much stronger and more commonly reported than child health-related motivations, although child health and guilt over exposing children to SHS were also cited as motivators for home smoking restrictions by some smoking mothers. The social norm that cigarette smoke is a nasty stale smell is strong. Further research in this area may be able to confirm whether such norms could be used in future intervention campaigns in addition to health warnings in order to promote smoke-free homes.

Area level factors

2.3.16 Urban versus rural

In the US smoking prevalence is higher in rural counties within states than it is in urban counties (Eberhardt & Pamuk, 2004; Kegler & Malcoe, 2002). According to research conducted by Berg et al (2006), the determinants of smoke-free homes in rural counties only are similar to the determinants of smoke-free homes in general which suggests that it is something about the urban culture and their social norms that determine the lower prevalence of smoke-free homes.

In England, rates of smoking are higher in urban areas; this is thought to be the case because smoking prevalence is higher amongst lower socio-economic groups and these groups tend to live in more built up urban areas than in rural areas (Amos et al., 2011). England is therefore quite different to the US. It is likely that in England a measure of urbanity of dwelling is a proxy measure for SEP. It is unclear whether this area level factor (the level of urbanisation of a dwelling) explains any of the variance in the prevalence of smoke-free homes or children's SHSe over and above that attributable to SEP. If this were the case then there is arguably a case for the specific targeting of urban areas and other factors specific to urban areas.

2.3.17 Summary

It is clear that the smoking status of parents and their home smoking policy are very important determinants of children's SHSe. In the absence of quitting, the goal must therefore be to encourage smokers outside using well-planned evidence-based interventions. This is in line with the standpoint of the current Coalition Government who have a strong preference for evidence-based interventions in public health.

Child SHSe consistently varied by measures of SEP with greater exposure amongst those most deprived as measured by social class, education, number of adults residing in the household and number of cars. It has been suggested that amongst deprived groups there are environmental constraints on smokers' ability to smoke outside. It might be the case that those living in more deprived circumstances live in high rise apartments with no easily accessible outdoor space. Additionally, the qualitative literature suggests that the size of one's garden and personal safety may also be pertinent issues. Availability of appropriate outdoor space and its relationship with indicators of SEP warrants further attention.

There has been a lot of discussion around knowledge of the dangers of SHS to child health and many statements made that smokers know SHS is harmful. However, the evidence does not necessarily support these statements. It would be worthwhile to assess specific knowledge of the illnesses caused by SHS and the role that this plays in children's SHSe.

The ecological approach suggests that in addition to individual factors, both the context and the environment are important to consider in relation to human behaviour, therefore changes over time as policy has changed may aid the interpretation of children's SHSe today and suggest how tobacco control has contributed to any changes.

Very few studies have explored the multivariate determinants of smoke-free homes on a national level, and so the majority of studies included in the above review do not account for the potential confounding impact of each predictor on the other. Furthermore, the majority of studies tend to focus on sub-populations which limit the applicability of the data to the general public. However, when the findings from the many studies in this area are synthesised, the same patterns have been found in different countries and in disparate groups within the same country.

Despite a relatively large (if disjointed) body of literature on the determinants of smoke-free homes, including modifiable and non-modifiable factors, this body of evidence is not matched with a literature on how best to secure increases in smoke-free homes. According to three reviews of individual focused and some community level interventions aimed at increasing the prevalence of smoke-free homes, there is no compelling evidence to support any particular intervention aimed at reducing the prevalence of children's SHSe to date (Gehrman & Hovell, 2003; Priest, et al., 2008; Roseby, et al., 2002). However, there is some suggestion in these reviews that interventions centred on individual counselling that were based on behaviour change theory and of sufficient intensity and duration generated the most promising results. Whilst interventions where a health practitioner gave brief advice were more common, household based interventions were found to be more effective.

One study included in the review found significant differences in cotinine levels between treatment and control groups (Hovell et al., 2000). Mothers with a child under 4 years of age were given seven counselling sessions using behavioural techniques (shaping, reinforcement and stimulus control) over a 3 month period. There was a considerable reduction in child SHSe in both the intervention and control groups, from 27 to 4.5 cigs per week in the counselling group, and from 24.5 to 12 cigs per week in the control group. Nevertheless, this difference between the groups over time was statistically significant suggesting a positive effect of the intervention. Similarly, Emmons et al (2001) conducted a RCT using motivational interviewing (MI) with 291 low-income families with children aged under 3 years. A 30-45 minute MI session was followed by 4 follow up MI phone calls. Smokers were also given feedback on the air nicotine concentrations in their homes. At 6 months post-intervention, exposure levels as measured by the monitors were significantly lower in the intervention group than in the control group. A more recent RCT assessing the impact of parent counselling for those with children with asthma who were highly exposed to SHS (≥10ng/ml) found no statistically significant effect of the intervention on SHSe or use of health care services overall, but did find a significant impact for those children with high-risk asthma (Wilson, Farber, Knowles, & Lavori, 2011). This may be suggestive that in addition to the knowledge that SHS causes exacerbations in asthma, perceptions of the level of risk posed by SHSe played a significant role in decisions to limit children's SHSe.

Therefore, despite its modesty, there is some evidence to support the efficacy of counselling interventions delivered in the home (NICE, 2009). But it is clear that further research in this area is necessary to produce a stronger, more reliable evidence base.

Using the findings from Phillips et al's (2007) qualitative research with 50 adults (both smokers and non-smokers who live with smokers) in Scotland, a panel of experts which included health promotion specialists, public health workers, members of the tobacco control alliance, community health partnership, smoking cessation coordinators and those working on community smoking initiatives, discussed ways in which public health initiatives could intervene with a view to increasing the proportion of smoke-free homes. Some of the key findings of Phillip's and colleagues' study were: that there are varied understandings of the health risks of SHS, variations in home smoking restrictions (and the facilitators and barriers of these), the home as a private space is a powerful view, and that few thought that SFL had changed their smoking behaviour.

The expert panellists agreed that unless the general public were knowledgeable about the illnesses caused by SHS and the limited effect of some half-way measures such as opening windows, interventions to reduce SHSe in the home would be of little impact. The panel believed that health professionals had gaps in their knowledge and this led to knock on effects of not giving advice because they were not clear on the risks themselves. This also requires addressing in future interventions. There was agreement that messages to smokers needed to be consistent (regardless of the delivery method), appropriately targeted and occur via cooperation and coordination between national and local organisations.

Although smoke-free homes were considered the gold standard, harm reduction techniques were considered necessary in some cases where social and environmental constraints provide a significant barrier to a comprehensive ban on indoor smoking i.e. lack of appropriate outdoor space and resistance from family members. However, there was concern about diluting the message and causing confusion about what level of SHSe is safe. The panel called for more research to determine whether those who implement partial restrictions do then go on to implement full restrictions. There is no evidence on this to date. Going forward, the panel felt that attaching campaigns onto the increased public discourse of child protection would help make smoke-free homes a reality. However, whilst the expert panel discussed the merits and problems associated with individual and community level interventions and dismissed the use of legislation in the private domain, they did not discuss the potential role of national nor regional mass media campaigns.

At the highest level of intervention (population level) mass media campaigns have been utilised in an attempt to increase the prevalence of smoke-free homes. Although there are very few evaluations of the efficacy of these SHS-related campaigns, there is a large body of literature on anti-smoking campaigns in general. The following section discusses how mass media has been used in an attempt to reduce the prevalence of active smoking, how it is often the case that only modest impacts should be expected as a result of mass media campaigns and how each individual campaign can be made as effective as possible.

2.4 Mass media and communication strategies

2.4.1 Reducing smoking prevalence

In the tobacco control field, it is now widely accepted that well-funded, frequently presented and sustained mass media campaigns which aim to reduce population smoking prevalence are associated with: heightened public consciousness of the dangers of smoking, increased public dialogue regarding smoking, increased use of cessation services, reductions in smoking prevalence amongst adults and decreases in the number of young people taking up smoking (Bala, Strzeszynski, & Cahill, 2008; Brinn, Carson, Esterman, Chang, & Smith, 2011; Durkin & Wakefield, 2009; Farrelly, Niederdeppe, & Yarsevich, 2003; NCI, 2008; Niederdeppe, Fiore, Baker, & Smith, 2008; Wakefield et al., 2008; WHO, 2011). A systematic review of eleven mass media intervention studies which aimed to increase smoking cessation amongst adult smokers found positive impacts in eight of the eleven studies reviewed (Bala, et al., 2008). However, it is difficult to determine the unique contribution of such mass media campaigns within a broader comprehensive tobacco control strategy. Yet it is the case that reductions in smoking behaviour are more apparent when mass media campaigns are conducted in this context. For example, the CTCP introduced the first anti-tobacco advertisements seen on TV in 1990, however tobacco control activities had started earlier in 1988 with increased excise taxes on tobacco products being used to fund the CTCP. During this time, smoking prevalence decreased from 23.3% in 1989 to 18.0% in 1993, this rate of decline was significantly faster than in previous years prior to the inception of the CTCP (-1.06, $p<.05$) and importantly this decline was greater than the decline witnessed in the rest of the US. When adjusting for the impact of other factors, it was found that mass media alone accounted for a decline in consumption of 7.7 packs per capita between April 1990 and March 1991 (Bala, et al., 2008; Pierce, et al., 2002). Positive effects were also found state-wide in Massachusetts in the US

and in Sydney and the North Coast of Australia as well as community-wide in smaller US and South African studies.

A positive impact of mass media campaigns was also found in the one English study included in the Bala 2008 review. McVey and Stapleton (2000) found a 1.2% decline in smoking prevalence in the intervention regions (TV regions: Granada, Tyne Tees and Yorkshire) attributable to the effects of the media campaign compared to the control region (Central). This campaign is described in context below.

Between 1992 and 1995, the 'John Cleese campaign' was conducted in an attempt to motivate smokers to quit and to prevent those smokers who had recently quit from relapsing. Background target audience research found that celebrity endorsement of anti-smoking messages was a popular and welcomed idea (McVey & Stapleton, 2000). Therefore, comedic actor John Cleese was asked to star in an anti-smoking mass media campaign using his trade-mark black humour. A range of ads were produced and aired; 10 were aired in both waves of advertising, but in the second wave, 5 of the ads aired in the first wave were replaced with 4 new ones in order to keep the campaign fresh. Although there is no information available on all of the adverts, McVey and Stapleton include information on 3 of these ads. One starts with Cleese as a dead man on a slab in a morgue before sitting up to talk in a serious tone about giving up smoking. He lists the dangers of smoking and then encourages cessation by giving figures on how many people have successfully quit. The ad finishes with Cleese saying 'Give up – it's better than being one of these' before he lies down and pulls a sheet back over his body. A second ad shows Cleese pouring ashes from an urn into an ash tray and saying ' this is how much ash a 20-a-day smoker makes', which initially makes the viewer think that's the amount of ash from 20 cigarettes until Cleese delivers the punch line, 'of course, they're not all cremated – some are buried'. Thus making it clear that a 20-a-day habit can kill the user. Another ad shows Cleese resisting relapse to smoking and telling the audience that giving in to just one will be enough to 'get you hooked again'. He advises those tempted to remind themselves why they gave up in the first place. He advocates filling a jar with old cigarette butts and water and then 'giving it a good long sniff' to put you off the idea. Each of the ads is followed by a Quitline number to call for help with giving up.[6] During the course of the campaign the

[6] All of these ads are still available to view on you tube

Quitline received around 20,000 calls in the two intervention regions (McVey & Stapleton, 2000; NICE, 2000).

Following two waves of advertising (Dec 1992-Mar 1993 & Dec 1993-Mar 1994), 18 months after baseline measures were taken, smoking cessation and maintenance was more likely in the TV campaign intervention region (OR 1.53, 95%CI 1.02-2.29) than in the control region (McVey & Stapleton, 2000).

However, in 1995 there was a shift away from delivering health messages towards supportive messages encouraging smokers to quit by focusing on the benefits of quitting as it was believed that smokers already knew about the health impacts of smoking and it was necessary to shift those motivated to quit into quitting and staying quit. These types of messages were used in the 1995-1996 *Break Free* campaign and the 1996-1997 *Quit for Life* campaign. These campaigns had little to no impact on smoking prevalence as indicated by the stagnation in smoking prevalence in the latter half of the 1990s. Whilst smokers reported that they would like encouragement to quit, these campaigns were easy to dismiss because they were too soft (NICE, 2000). At this time research in Australia suggested that harder messages that aroused fear in smokers could be used successfully without alienating smokers (D. Hill, Chapman, & Donovan, 1998).

Since 1997 and the *Quit for Life* campaign, subsequent nationally led anti-smoking mass media campaigns have tended to be more hard-hitting, such as the 'emotional consequences campaign' in 2004 where smokers with fatal illnesses spoke about the realities of smoking-related illness from their hospital beds, for example, one of the adverts featured a 58-year old man (Mr Hicks) with throat and lung cancer struggling for breath whilst talking about his daughter coming to visit him from the US. The ad ends with a statement that Mr Hicks died before his daughter arrived (DH, 2012).

Recent research has found that campaigns that use fear appeals by showing people suffering or dying from smoking related illness are particularly influential in motivating smokers to give up smoking (Davis, Nonnemaker, Farelly, & Niederdeppe, 2010; Dunlop, Wakefield, & Kashima, 2008; NCI, 2008; WHO, 2011). It is likely that this is because the perceived risk of illness and the perceived severity of such illness is elevated in those perceptive to the messages (Norman, Conner, & Bell, 1999). In order for ads to resonate with younger audiences (those who it is most important to stop becoming lifelong

smokers), then these fear appeals must focus on those who die young as a result of smoking (White, Webster, & Wakefield, 2008). The Truth campaign in California has done just this (www.truth.com).

The withdrawal of mass media campaigns has been associated with a decline in the beneficial effects found during and immediately following a campaign (Ibrahim & Glantz, 2007; NCI, 2008; Niederdeppe, et al., 2008; Wakefield, et al., 2008)

2.4.2 Modest impact of mass media campaigns

Despite their widespread use, a meta-analysis of health promotion mass media campaigns found that those campaigns that aim to motivate individuals to desist with a behaviour (e.g. stop smoking) or qualitatively change an pre-existing behaviour (e.g. reduce alcohol consumption) generally have less success than those campaigns which focus on the performance of a novel behaviour such as wearing a seat-belt (Snyder & Hamilton, 2002). In general, mass media campaigns that aim to change risky health behaviour have had some success, but more often than not, the level of success has been modest. Suggestions for why this is the case are presented here, using tobacco smoking as the relevant example. For example the 'John Cleese campaign', which was considered a success, was estimated to have led to an overall reduction of 1.2% in smoking prevalence in England, a relatively small change but one which translates into changes in behaviour amongst thousands of individuals.

It has been suggested that when the population needs to move toward a new social norm about the appropriateness of a behaviour, communication programs should be expected to achieve change only *very slowly* (Hornik, 2002). For example, using the USA as an example, the decline in smoking prevalence has been 1-2% per year over three decades. This decline has coincided with a synonymous decrease in the acceptability of smoking in the US. This phenomenon is also true of other developed countries, including England.

Snyder and Hamilton (2002) conducted a meta-analysis of 48 studies that aimed to change health behaviour. They argued that many case studies of individual health promotion campaigns yielded disappointing results because the type of evaluation was not appropriate to the expected behaviour change. Interventions with a small effect size (i.e. a small amount of change – which can be counted as success of the intervention) are only

detectable using large sample sizes. It is commonly very difficult or expensive to gather a large enough sample size of the desired population.

The ecological approach would suggest that the modest impact of such mass media campaigns pertain, in part, to the fact that only the individual determinants of health are addressed. Most media interventions do not address the interpersonal, social network, community or organisational level factors that have a role in the maintenance of smoking behaviour (Abroms & Maibach, 2008). These levels are referred to as levels of influence from this point forwards.

It is for this reason that mass media campaigns are found to be most effective in reducing smoking prevalence when they are incorporated into comprehensive tobacco control strategies that are well funded as this can lead to synergistic effects where multiple interventions at various levels of influence combine to produce much larger reductions than the predicted impact of individual interventions (NCI, 2008; Bala et al, 2008, WHO, 2011; CDC, 2007; Frieden et al, 2005).

Nevertheless, the majority of anti-smoking media campaigns have focused on the individual determinants of personal smoking behaviour, i.e. quit smoking. They have not attempted to influence the wider determinants of behaviour promoting supportive family environments or campaigns aimed specifically at policy makers.

The aforementioned 'people and places' framework proposed by Maibach and colleagues (2007) proposed that communication and social marketing interventions can be used to do just this. For example, they argued that within social networks it is possible to recruit individuals to serve as agents of health behaviour change. For example, in Wales, this has occurred with 'A Stop Smoking In Schools Trial' (ASSIST), whereby pupil elected representatives were trained to give smoking-related information to their peers and encourage them not to smoke in 31 intervention schools (Campbell et al., 2008). Smoking uptake was compared between pupils in these schools and pupils in 29 control schools. Smoking in the past week was measured immediately post- intervention and then again 12 months and 24 months later. Whilst the impacts of the intervention were modest at each follow-up time point, when all time points were collated, and a multilevel analysis performed, those who took part in the intervention were significantly less likely than those in the control group to start smoking (OR:0.78 95% CI 0.64-0.96). The authors suggested

that if this intervention was rolled out nationally then it could have a significant impact on future smoking prevalence. In a similar peer-led context, Robinson, Ritchie, Amos et al (2011) have suggested that individuals who are committed to restricting smoking in their households can have a positive impact on the behaviour of their family and friends through increased dialogue of the issues surrounding SHS and by role modelling smoking restrictive behaviour. Therefore, there may be a case to promote such communication activities.

Furthermore, at the community level, Maibach et al (2007) proposed that civic journalism can have an influential role in modifying smoking norms and behaviours. Civic journalism is a concept whereby pertinent community issues are discussed in the local news and members of the community actively contribute their views to these news stories , fuelling debate and discussion. Maibach proposes that by reporting on the issues of child SHSe and inviting public opinion on the topic, heightened consciousness and relevance of the issue amongst the community can be achieved. This can be viewed as complementary to policy advocacy or media advocacy whereby public health issues are framed in a certain way to create news interest, spark debate and make policy makers take notice of a selected issue. Media advocacy has been successfully used in Australia (McLeod et al, 2008) to shape how issues surrounding tobacco use were publically defined and discussed. Between 1995 and 2005 articles that were supportive of tobacco control initiatives made up the majority of smoking related articles in a newspaper called 'The Age' as a result of the public health community framing and publicising their desired messages to the media. During the time in which these articles dominated there was increased public acceptance of SFL and anti-tobacco advertising. The tobacco industry has used media advocacy for years and now tobacco control and the tobacco industry are in direct competition fighting for their view of tobacco related issues to be the most publicised in the media (Nagelhout, van den Putte, de Vries, Fong, & Willemsen, 2012). This is currently the case in terms of portraying the arguments of each side in relation to standardised packaging legislation.

Whilst acknowledging that mass media campaigns aiming to address the individual determinants of behaviour work best as part of a wider comprehensive tobacco control program that precipitates change at multiple levels, the following section provides a summary of what works in campaigns focused at changing the individual determinants of behaviour in terms of media campaign content and the process of effective implementation and evaluation.

2.4.3 SHS Mass media campaigns

In addition to reducing the number of smokers, another fundamental public health objective of tobacco control interventions is to reduce the SHSe of non-smokers and children. To date, there are no known systematic reviews or meta-analyses of the impact of mass media campaigns that aim to reduce SHSe in the home.

In 2009, Kosir and Gutierrez published a 'review' of 30 mass media campaigns that aimed to reduce SHSe; twelve focused directly on increasing the prevalence of smoke-free homes. However, the authors are clear that this review is neither exhaustive nor systematic and that the information gathered on each campaign is not comprehensive enough to conclude which individual campaigns have been most successful. Furthermore, each individual campaign included in the report varies considerably in quality; in terms of the campaign and the evaluation used to ascertain its impact. For example, none of the regional campaigns included in the review reported use of a control group. Therefore, any changes found cannot be emphatically attributed to the campaign as small changes may be due to a number of reasons, not least, secular trends. Nevertheless, the review does identify key components common to several of the campaigns that are likely to have made a positive contribution to the reduction of SHSe over time in their respective countries. These key components are sub-divided into two groups; process components and content components. The authors claim that the former process components used to plan, implement, monitor and evaluate mass media campaigns are as important as the actual content components of the campaign (Kosir & Gutierrez, 2009).

Process

i) Target audience research and pre-campaign evaluation of materials will improve the likelihood of success.

ii) Measuring campaign outcomes requires data collection before and after the campaign[7]

iii) Television is the strongest medium for reaching the maximum amount of people.

[7] A review of the literature in this thesis would suggest using routinely available dataset where possible so that there is sufficient pre-campaign data to account for potential secular trends, if this is not possible then a control group would be the next best option.

iv) Multiple outreach strategies broaden a campaign's penetration. Multiple strategies can include both paid media (Television, radio, print, outdoor, internet advertising including the use of social media) and earned media (public relations events, working with news outlets and reporters to get articles placed, etc.) as well as outreach activities, such as distributing brochures to community events, manning booths at community events, coordinating with health care providers, and other local interventions. This is in accordance with the ecological approach although the targets for change are mostly individual determinants of health behaviour i.e. knowledge of the dangers, multiple levels of influence are being utilised to deliver the message.

v) Advertisements developed in one country can be adapted effectively to other countries and can serve to guide other campaigns' creative development, e.g. Cigarettes are eating you and your kid's alive campaign developed initially in New York and adapted for use in Australia.

vi) Sizeable and consistent advertising placements can contribute significantly to campaign success.

Content

i) Testimonials, or personal stories can persuasively and credibly communicate the dangers of SHS and the need to protect people from it.

ii) Focusing on the health impacts of SHS appears to be an effective strategy for raising awareness and building knowledge of the dangers of SHS, changing attitudes about SHS and building support for protecting people from it, although there is some evidence to suggest that highlighting the negative aesthetic factors also have a role to play (Jones, et al., 2011).

iii) Ads that elicit negative emotions or discomfort from the audience typically generate high levels of persuasiveness, even when the ads are not perceived as enjoyable.

iv) Portraying innocent victims exposed to SHS can motivate smokers to avoid smoking around others particularly in personal settings such as homes and cars.

v) Showing the impact of SHS on children generally mutes smokers' arguments about individual rights to smoke (i.e. help combat cognitive dissonance).

vi) Focusing on protecting one segment of the population from SHS provides strategic specificity and clarity, i.e. focus on children.

vii) Advertisements that do not attack or demean smokers are typically better accepted by smokers (and in some cases even by non-smokers), influencing smokers to change their behaviours more effectively than messages perceived as critical or judgemental of them.

viii) Successfully communicating with specific populations requires understanding how members of that population view themselves in relation to the mainstream culture and how they prefer to be portrayed.

ix) SHS campaigns may motivate some smokers to quit, so campaigns should plan accordingly, i.e. provide a Quitline number.

In short the authors proposed that the most important components for a successful SHS-related mass media campaign were, target audience research and pre-campaign piloting of materials (Television ad, print ads, etc.) to ensure that the target audience react the way campaign planners anticipate. Television ad content should be adapted from previous campaigns in other countries that have found to have an impact to save money that might be better spent on campaign reach, by running campaigns for longer and more frequently, (e.g. the 'cigarettes are eating you alive' campaign has been successfully utilised to reduce smoking prevalence in many countries since its initial development in New York). Furthermore, a SHS-related campaign called *Cigarettes are eating you and your kids alive* was developed the US using the original active smoking ad as a template, which has now been utilised in other countries such as Russia, Poland, the Ukraine and Vietnam (World Lung Foundation, n.d). Multiple outreach strategies such as television, print media, billboards radio and earned media via public relations activities should be utilised. More recently social networking cites such as Facebook and Twitter can be successfully utilised to influence the public (Neiger et al., 2012). As mentioned previously in the case of active smoking advertisement, personal stories can credibly convey the real life negative consequences of SHSe and fear appeals can be effective when used in conjunction with adequate practical information on how to change the undesirable behaviour. Failure to do the latter can lead to denial of the campaign message all together as the target audience feel helpless to act (Witte & Allen, 2000) and campaign messages should be carefully constructed so that smokers are not directly criticised or demeaned.

In addition to the important characteristics identified above, the continual climate of committed tobacco control is imperative. Consistent engagement and health promotion messaging over many years changed the social norm regarding appropriate smoking

behaviour and achieved small but consistent year on year increases in the proportion of smoke-free homes in countries such as Australia, Canada and New Zealand (Chapman, 2007; Kosir & Gutierrez, 2009).

2.5 Summary

Taken together, the findings of this chapter provide an overview of what is already known about the prevalence, trends of SHSe in the UK and some of the determinants of children's SHSe. Anticipated and unanticipated changes as a result of population based interventions such as the SFL were discussed. It has been proposed that public health interventions are most effective when guided by the ecological approach to behaviour change which suggests that interventions to change individual behaviour should be conducted at multiple levels. With this in mind, child SHSe over the last decade was discussed with reference to the concurrent changes in tobacco control in the UK, before the many determinants of children's SHSe were discussed. There were a number of incidences where further research is warranted. Some of these factors are the focus of this thesis. Finally, given that there is no gold standard in how to reduce SHSe in the home, the usefulness and expected impact of mass media campaigns was discussed.

Previous research provides information on children's SHSe based on total household smoking restrictions. The first results chapter of this thesis (Chapter 3) uses a different nationally representative routinely available dataset to confirm these trends and to explore the prevalence of partial measures taken to limit SHS in the home. This chapter sets the scene for the rest of the thesis. Chapter 4 explores the multilevel determinants of children's cotinine levels and suggests where future interventions are best targeted. Chapter 5 looks closely at people's knowledge of the specific illnesses that are related to SHSe. Then the relationship between this knowledge and both full and partial SHS-protective behaviours are assessed. Knowledge can be increased through the use of mass media campaigns. Chapter 6 discusses a case study of a mass media intervention in the North West and North East of England that was implemented with the goal of encouraging more smokers with children to make their homes smoke-free. The findings of each of these chapters are discussed in brief discussions at the end of each chapter and are brought together in chapter 7 in order to make some unique conclusions of the research and make recommendations for tobacco control based on the findings.

CHAPTER 3. PROTECTING CHILDREN FROM SECOND-HAND SMOKE IN THE HOME: WHAT ARE SMOKERS DOING?

3.1 Introduction

Between the mid-1990s and 2009, studies utilising the HSE showed a marked secular trend towards smoke-free homes and a corresponding reduction in children's exposure to SHS (Jarvis, et al., 2009; Jarvis, et al., 2011; Sims, et al., 2010). However, these studies also showed that amongst smokers, the prevalence of total smoking restrictions in the home was low. Yet, this does not necessarily mean that smokers are taking no action to protect children from their tobacco smoke; these studies did not examine other SHS 'protective' behaviours.

Some studies (predominantly qualitative) report that many smokers adopt half-way measures to protect children, namely: restricting smoking to particular rooms or smoking only at certain times (e.g. when the children are in bed or at school), or opening windows and doors (Robinson & Kirkcaldy, 2007a). For example, qualitative work in Australia found that parents open windows and smoke in open doorways in the belief that it reduces their children's exposure, which in turn helps alleviate parental guilt (L. Hill, et al., 2003). This is further supported by work in Scotland where the presence of children was cited as the main reason for both total and partial smoking restrictions in the home because of concern about the possible health risks (Phillips, et al., 2007).

The national prevalence of such behaviours (i.e. partial home smoking restrictions) has not been explicitly tested in any of the studies reviewed in the last chapter. No studies to date have attempted to quantify how many smokers take at least some preventive measures to protect their children from SHS in England. Although we know that strict no-smoking policies in the home are associated with significantly lower levels of exposure in children compared with when there are no smoking restrictions in the home (Jarvis, et al., 2009; Johansson, Hermansson, & Ludvigsson, 2004; Wakefield, et al., 2000), and that less restrictive measures such as opening windows or limiting smoking to a single room are thought to have much less impact (Ashley & Ferrence, 1998) , it may be the case that those who take some protective measures are reducing children's exposure to an extent and may

form a group of smokers who are amenable to further change possibly via targeted interventions.

When smokers engage in what they perceive to be harm reduction behaviours it suggests that the social norms regarding SHSe are changing and that smokers increasingly perceive child SHSe as unacceptable. These 'harm reduction' behaviours may represent a necessary step in the right direction in the battle for a ubiquitous increase in smoke-free homes. If parents are told that their current methods are not as effective as they might believe and they are motivated to protect their children then there may be a chance that they might make their home completely smoke-free. Furthermore, smokers may be increasingly under pressure to protect children from SHSe due to the continued denormalisation of smoking behaviour and the concurrent increase in the desire to be seen as a 'considerate' smoker (Poland, 2000; Poland et al., 2006).

Given the political controversy over transfer of smoking from public places to the home following SFL, this chapter hopes to confirm that there has been no decrease in the proportion of smoke-free homes since the implementation of the SFL. Given that smoke-free home prevalence in 2007 was low amongst children living with one smoking parent (37%) and 2 smoking parents (21%) (Jarvis, et al., 2009) it is important to understand whether smokers employ any other partial restrictions in an attempt to protect others and whether this has changed over time. To further decrease child SHSe in homes with smokers, we need to understand smokers' home smoking behaviour and identify targets for change. To assess the extent to which efforts to increase smoke-free homes might lead to public health benefits we need to know more about the proportion of smokers currently living in smoking households that might be amenable to changing their behaviour, namely those who already take some preventative measures.

3.2 Methods

3.2.1 Data

Analysis of repeat cross-sectional data (1997-2008) of the nationally-representative Omnibus Survey (latterly known as the Opinions Survey from 2008) was conducted. The Omnibus Survey (OS) is a monthly survey conducted using a multistage design by the Office of National Statistics, to produce a nationally representative sample of adults living in

private households in Great Britain, with one adult interviewed per household. Full details of are available online: http://www.esds.ac.uk/government/omnibus/resources/.

A smoking module was conducted in October and November every year (November and December in 1997). Between 1997 and 2004, approximately 1800 adults were interviewed each month; since 2005 this number reduced to approximately 1200. Response rates over the 12 years ranged from 61% to 70% of the eligible sample. As only one adult is selected per household, adults living in households containing more than one adult have a lower probability of selection. A weighting factor was applied to correct for the unequal probability of selection. In 2008 a sampling error was made by ONS and as a result the October-November 2008 survey was re-run in February and March of 2009 (Lader, 2009). These data are still referred to as 2008 data both by ONS and in this chapter, but this caveat was considered when interpreting the results. The smoking module of the OS was discontinued after the February-March 2009 survey.

3.2.2 Outcome measures

3.2.2.1. Smoke-free homes

From 2006, respondents were asked *"Which statement best describes the rule on smoking inside your home?"* Respondents were asked to indicate that smoking is not allowed at all, smoking is allowed in some rooms or at some times, or that smoking is allowed everywhere. When assessing the presence of a smoke-free home, only those who indicated that smoking is not allowed at all qualified as having a smoke-free home. Those who indicated that smoking is allowed at some times or in some rooms were grouped together with those who allowed smoking everywhere.

3.2.2.2. Smoking abstinence with children

From 1997, smokers were asked about their smoking behaviour when in a room with a child; whether they smoked the same number of cigarettes as usual, smoked fewer cigarettes, did not smoke at all, or other. Smoking abstinence was taken as complete self-denial, those who smoked fewer cigarettes and those who smoked the same as normal were grouped together as non-abstinent.

3.2.3 Analyses

First, the proportion of smoke-free homes was assessed (2006-2008) for all respondents. Then the proportion of smoke-free homes was stratified by smoking status, and the presence or absence of children in the home. After exploring the prevalence of smoke-free homes in England, I examined the proportion of smokers that abstained from smoking when in a room with children from 1997 to 2008 and assessed whether this varied by cigarette consumption, social class, living with children and the presence or absence of a smoke-free home. Differences were assessed using univariate regression analyses. All analyses were undertaken using SPSS 18 (PASW 18). The data were analysed with adjustments made for the OS complex sampling design. A weighting factor was applied to correct for unequal probability of selection.

3.3 Results

The sample distribution for gender and age for each annual sample are consistent with national population estimates (ONS, 2012). A total sample size of 29,429 respondents was obtained across the 11 year period. Within this sample, approximately 50% of respondents had never smoked, 27% were ex-smokers, and 23% were current smokers (17% light and 6% heavy-smokers). OS annual smoking prevalence rates show that, in line with other national surveys (S. Robinson & Lader, 2009), smoking prevalence decreased from 28% in 1996 to 21% in 2007 (Table 3). However, in 2008 we found an inconsistency; the OS data showed smoking prevalence was 19% whereas in the GHS it remained at 21%.

3.3.1 Smoke-free homes

Overall, the prevalence of smoke-free homes increased significantly year-on-year, from 61.4% in 2006 to 71.5% in 2008 (Table 4). For smokers only the proportion of smoke-free homes increased from 26.5% in 2006 to 29.8% in 2008. This increase was not statistically significant. In 2008, smoke-free home prevalence was much higher amongst non-smokers than smokers with 81.4% of non-smokers reporting a smoke-free home compared with only 29.8% of smokers. For non-smokers and smokers alike, the presence of children in the home increased the prevalence of smoke-free homes to 87.0% and 39.3%, respectively. Compared to those living with children in the home, those who lived with at least one other adult, but not with children, had a lower incidence of smoke-free homes. This was true of

both non-smokers (80.3%) and smokers (30.5%). Of those smokers who lived alone in 2008, only a small minority reported having a smoke-free home (10.7%).

3.3.2 Smoking abstinence in a room with a child

Between 1997 and 2008, the proportion of smokers taking preventative action by remaining abstinent from smoking when in a room with a child has increased significantly in absolute terms by 22% from 57.4% (95% Confidence interval 53.6-61.0%) in 1997 to 78.6% (95% CI 73.6-82.9%) in 2008 (Table 5).

In 1997, smoking abstinence varied significantly between those in the highest social class group (managerial and professional) compared to those in the lowest social class group (part-skilled and unskilled occupation; Figure 7). By 2008 the same proportion of smokers (82%) from managerial and professional occupations and part skilled and unskilled occupational groups reported abstinence. Amongst those of part-skilled or unskilled occupation there has been an increasing trend in abstinence since 1997, whereas those of managerial and professional occupation saw little change between 2001 and 2006. There was a marked increase between 2006 pre-legislation and 2007 post-legislation for both of these social class groups in comparison to increases seen in earlier years. However, these increases were not statistically significant.

There was also a convergence in smoking abstinence rates between light and heavy smokers (Figure 8). Heavy smokers are those who smoked 20 or more cigarettes daily, and light smokers are those who smoked 19 or less each day. In 2006, 65.5% (95% CI 61.2-69.6%) of light smokers abstained from smoking in a room with a child compared to only 37.8% (95% CI 31.4-44.7%) of heavy smokers. However, there has been an upward trend in abstinence amongst heavy smokers in particular. In 2008, abstinence levels were much less divergent with 80.6 % of light smokers and 73.8% of heavy smokers reporting abstinence.

In addition to social class and level of consumption, the proportion of smokers who reported abstinence when in a room with a child varied dependent upon smokers' cohabitation characteristics (3.3.2.1) and whether or not they had a smoke-free home (3.3.2.1). The following section assesses the relationships between these factors and smoking abstinence.

Table 3 Characteristics of the OS England sample (1996-2008): Proportion of respondents in each socio-demographic subgroup (%)

Socio-demographics	1996®	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008*	Total
Gender													
Male	49	46	46	49	43	46	46	46	45	46	47	45	**15,101 (46)**
Female	51	54	54	51	57	54	54	54	55	54	53	55	**17,529 (54)**
Age group													
16-24	12	13	13	12	13	12	14	12	11	12	11	9	**4,008 (12)**
25-44	38	36	37	35	35	34	34	35	36	34	33	31	**11,450 (35)**
45-64	32	33	31	32	31	33	32	33	32	34	35	36	**10,585 (32)**
65+	18	18	19	22	21	20	20	20	21	20	20	24	**6,587 (20)**
Smoking status													
All smokers	28	25	26	25	23	25	23	22	22	24	21	19	**7,924 (24)**
Light (0-19/day)	19	17	18	17	16	17	16	16	16	18	15	5	**2,244 (7)**
Heavy(20+/day)	9	8	8	8	7	8	7	6	6	6	6	14	**5,680 (17)**
Ex	26	28	28	28	26	26	26	28	26	27	27	36	**8,917 (27)**
Never	46	47	46	47	51	49	51	50	51	49	52	55	**15,721 (48)**
Social Class													
Professional & managerial	32	30	34	34	33	32	34	33	32	31	34	36	**10,547 (32)**
Skilled non-manual & manual	41	42	39	38	42	42	39	41	42	41	39	40	**13,260 (41)**
Part skilled & Unskilled	23	23	23	21	20	19	19	19	19	19	19	16	**6,357 (20)**
Never worked/unclassified †	4	5	4	6	5	7	8	7	7	8	8	8	**2,465 (8)**
Total Sample	**3,202**	**3,174**	**3,003**	**2,881**	**3,032**	**3,316**	**3,050**	**3,095**	**2,097**	**2,013**	**1,956**	**1,812**	**32,630**

Note: Not all variable classifications will add up to the sample totals due to the missing data for those variables. † Not included in the final sample *Data collected in Feb/Mar 2009

Table 4 Trends in smoke-free homes in England, by smoking status and presence of children in the household (2006-2008)

	Prevalence of smoke-free homes (%) and 95% CI							
Homes..	***N***	**2006**	***N***	**2007**	***N***	**2008***	***N***	**Total**
All	2004	61.4 (59.1-63.7)	1942	66.7 (64.3-68.9)	1821	71.5 (69.2-73.7)	5767	66.4 (65.0-67.7)
…with children	556	65.4 (61.0-69.6)	473	76.0 (71.7-79.9)	449	76.1 (71.7-80.1)	1478	72.0 (69.5-74.4)
… with adults†	886	61.3 (57.9-64.6)	929	64.7 (61.5-67.9)	854	71.9 (68.6-74.9)	2669	65.9 (64.0-67.8)
Non-smokers	1509	72.7 (70.2-75.1)	1509	76.9 (74.4-79.1)	1465	81.4 (79.1-83.4)	4483	76.9 (75.6-78.2)
...with children	379	77.1 (72.2-81.4)	357	88.3 (84.1-91.5)	343	87.0 (82.8-90.3)	1079	83.8 (81.3-86.1)
...with adults†	709	71.8 (68.9-74.9)	757	73.1 (69.7-76.2)	717	80.3 (77.1-83.1)	2183	75.0 (73.1-76.9)
Smokers	495	26.5 (22.4-31.1)	433	29.1 (24.5-34.2)	355	29.8 (24.7-34.2)	1283	28.3 (25.6-31.2)
...with children	177	37.8 (30.2-46.0)	116	36.4 (27.2-46.6)	106	39.3 (29.8-49.6)	399	37.8 (32.7-43.1)
...with adults†	177	22.4 (16.8-29.3)	172	29.5 (22.9-37.0)	137	30.5 (22.9-39.4)	486	27.1 (23.2-31.5)
Live alone	141	12.1 (7.6-18.6)	145	16.6 (11.3-23.5)	112	10.7 (6.2-17.9)	398	13.3 (10.3-17.0)

†Smokers live with other adults in the home but not with children <16 years. *Data collected in Feb/Mar 2009

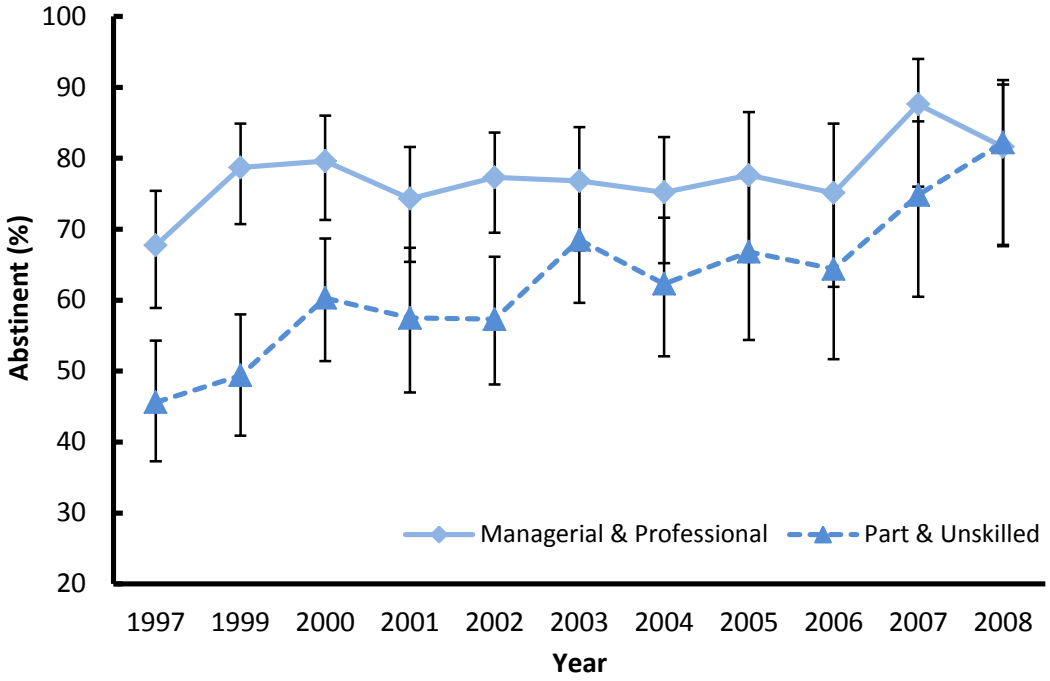

Figure 7 Prevalence of smoking abstinence in a room with a child by social class

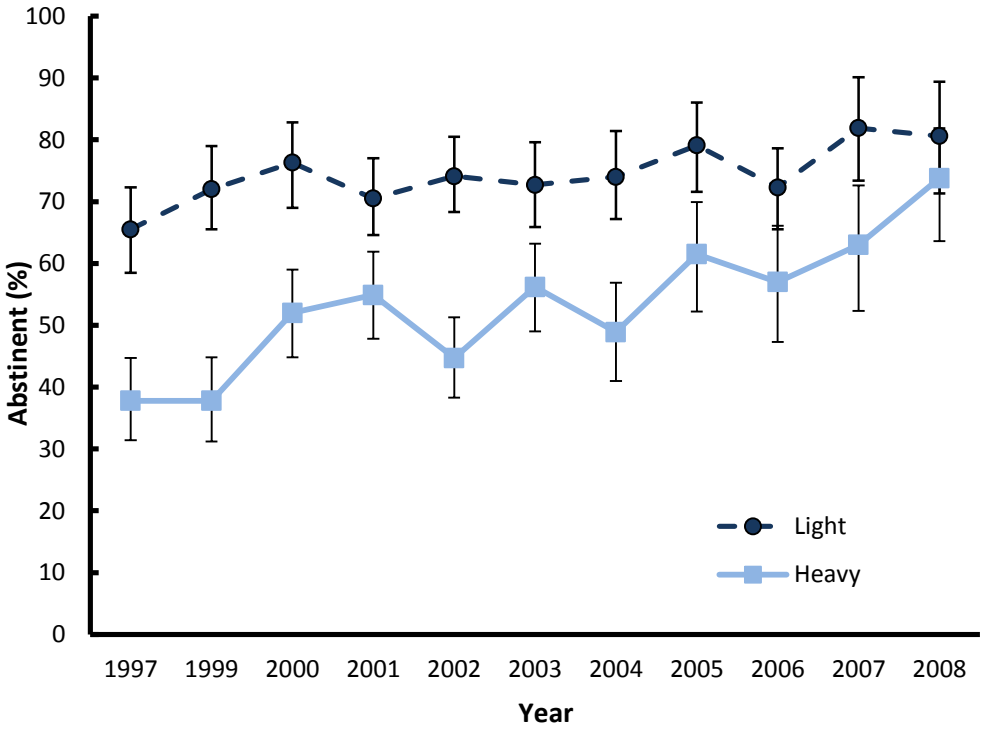

Figure 8 Prevalence of smoking abstinence in a room with a child by smoking status

3.3.2.1. Univariate predictors of smoking abstinence with a child

Univariate logistic regression analysis showed that smokers who lived with other adults but not with children were more likely to report abstinence when in a room with a child (70.0%) compared to smokers who do live with children (62.3%, OR: 1.30, 95% CI 1.14-1.48).

Smokers who had a smoke-free home had significantly greater odds of abstinence than those without smoke-free homes (OR: 3.64, 95% CI 2.44-5.42). Prevalence of abstinence was 88.7% (95% CI 85.4-91.9%) compared to 68.4% (95% CI 65.0-71.7%) respectively. Between 2006 and 2008, there was a significant increase in abstinence when in a room with a child for those who did not currently have a smoke-free home from 62.5% (95% CI 56.7-67.9%) to 74.8% (95% CI 68.6-80.2%). The odds of smoking abstinence increased by 1.21 (95% CI 1.06-1.39) with each year. There was no significant increase amongst those smokers with a smoke-free home (Table 5).

The proportion of smokers who lived with children and did not have a smoke-free home, but who were abstinent in a room with a child, increased non-significantly from 58.4% (95% CI 47.9-68.2%) in 2006 to 64.8% (95% CI 51.0-76.5%) in 2008. Over the same time period abstinence amongst this group decreased non-significantly for those with a smoke-free home from a promising 94.6% (95% CI 85.9-98.1%) in 2006 to 86.1% (95% CI 71.5-93.8%) in 2008 (Table 5).

When adjusting for smoke-free homes, those without children residing in the home were not statistically more likely to abstain from smoking when in the same room as a child compared to those with children (OR: 0.74 (95% CI 0.54-1.01), however, presence of a child made smoke-free homes more likely in the first place (Table 5).

These results are summarised and their implications briefly discussed here as their broader implications are discussed more fully in the conclusions in chapter 7.

Table 5 Smoking abstinence when in a room with children, by household composition (1997-2008)

	Percentage & 95% Confidence Interval (CI)											
Smokers' abstinence	**1997**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008***	**Total**
All	57.4	62.2	68.9	66.0	65.6	68.0	67.8	74.5	68.7	77.1	78.6	**67.3**
	(53.6-61.0)	(58.4-65.8)	(65.2-72.4)	(62.2-69.6)	(61.9-69.0)	(64.2-71.5)	(63.9-71.4)	(70.2-78.5)	(63.9-73.1)	(72.4-81.2)	(73.6-82.9)	**(66.1-68.5)**
Smoke-free home[8]	-	-	-	-	-	-	-	-	85.7	93.0	87.6	**88.7**
									(77.6-91.3)	(86.3-96.6)	(78.3-93.2)	**(85.4-91.9)**
Not a smoke-free home	-	-	-	-	-	-	-	-	62.5	70.5	74.8	**68.4**
									(56.7-67.9)	(64.5-75.9)	(68.6-80.2)	**(65.0-71.7)**
Children in the home	51.2	54.4	64.6	64.0	58.3	62.8	57.8	73.7	72.1	71.9	73.1	**62.3**
	(45.0-57.3)	(48.1-60.6)	(58.0-70.6)	(57.9-69.7)	(52.1-64.3)	(56.0-69.3)	(50.7-64.5)	(66.7-79.7)	(64.4-78.7)	(62.1-80.0)	(63.0-81.3)	**(60.2-64.4)**
Smoke-free home	-	-	-	-	-	-	-	-	94.6	92.9	86.1	**91.8**
									(85.9-98.1)	(79.6-97.7)	(71.5-93.8)	**(86.1-95.3)**
Not a smoke-free home	-	-	-	-	-	-	-	-	58.4	59.9	64.8	**60.5**
									(47.9-68.2)	(47.2-71.3)	(51.0-76.5)	**(53.6-67.0)**
Live with other adults only	59.7	65.7	72.0	67.3	70.1	70.9	74.1	74.7	64.2	79.5	83.8	**70.0**
	(54.2-65.0)	(59.9-71.0)	(66.4-76.9)	(61.2-72.9)	(64.8-75.0)	(65.3-76.0)	(68.4-79.1)	(67.3-80.9)	(56.5-71.3)	(72.5-85.1)	(76.3-89.3)	**(68.2-71.7)**
Smoke-free home	-	-	-	-	-	-	-	-	74.7	92.6	87.2	**85.4**
									(58.4-86.1)	(81.4-97.3)	(71.6-94.9)	**(77.8-90.7)**
Not a smoke-free home	-	-	-	-	-	-	-	-	61.2	74.0	82.3	**71.1**
									(52.2-69.5)	(64.9-81.3)	(72.9-89.0)	**(65.9-75.9)**

[8] **Omnibus Survey respondents were asked about whether or not they had a smoke-free (sf) home from 2006 onwards.** *Data collected in Feb/Mar 2009

3.4 Discussion

This study confirms that there was an increase in smoke-free home prevalence in England between 2006 and 2008, from 61% to 72%. In 2008, smoke-free home prevalence was greatest among non-smokers (81%) and lowest amongst current smokers (30%). There was no significant change in smoke-free home prevalence amongst smokers between 2006 and 2008, but importantly, given concerns about the possibility of transference of smoking to the home following SFL, there was no fall.

Despite finding no change in the prevalence of smoke-free homes amongst smokers between pre- and post-SFL, in 2008, a large proportion (65%) of smokers living with children in homes without a complete smoking ban attempted to reduce children's SHSe by remaining abstinent when in a room with a child. Unsurprisingly, those with a smoke-free home already, were much more likely to report smoking abstinence than those without a smoke-free home. Interestingly, even though those with children in the home were more likely to have a smoke-free home, they were less likely than those not living with children to abstain from smoking when in a room with a child. Amongst smokers living in a household in which smoking was permitted, a greater proportion of smokers that did not reside with children reported abstinence (71%) compared to smokers who did live with children (61%).

Amongst all smokers between 1997 and 2008, there has been a significant 22% absolute increase in smoking abstinence. When this trend was stratified by social class, it was clear that there have been marked increases amongst the lowest social class group (part-skilled or unskilled occupation), with abstinence increasing by 36% in absolute terms from 1997 to 2008. Amongst the highest social class group (managerial and professional occupation) the absolute increase was 14%. Overall, this is very encouraging as it suggests a reduction in inequalities with differences in protective behaviour by social class narrowing over the years. The fact that a very similar pattern was found for heavy versus light smokers is unsurprising as it is known that those of higher deprivation tend to smoke more heavily than those of lower deprivation (Bobak, Jha, Nguyen, & Jarvis, 2000). It would be helpful to biologically verify this reduced exposure of children, as it may be the case that smokers are responding to the pressures of increased stigmatisation of smoking over time and are therefore reporting behaviours that they do not practice in reality.

Nevertheless, the findings here are supported by data from the HSE which also showed that smokers are increasingly taking action to reduce children's SHSe (Jarvis, et al., 2009; Jarvis, et al., 2011; Sims, et al., 2010). Overall the results of this chapter suggest that over time an important cultural shift has occurred in the acceptability of exposing children to SHS and subsequently the majority of smokers are now making efforts to change their smoking behaviour accordingly. However, smokers may not know that refraining from smoking in the same room as a child does not offer children full protection from SHS and so further work to assess how protective smokers believe certain behaviours to be would provide further insight and help target future interventions. The efficacy of abstinence cannot be explored here; neither can the extent of the protective behaviour. Using the OS data it is not possible to explore the mechanisms that underlie smoking behaviour in private spaces, however, previous research has suggested that the decreased social acceptability of smoking, family pressure and increased knowledge of the adverse impacts of SHS may all play a part (RCP, 2010).

However, the barriers parents face with regards to implementing a smoke-free home must not be overlooked. Qualitative work in England and Australia suggest these barriers include a lack of knowledge of the dangers of SHS and a general mistrust or downplaying of scientific information on the risks, along with the inability to leave children unattended in the home, inclement weather and lack of suitable outdoor space (L. Hill, et al., 2003; J. Robinson & Kirkcaldy, 2007b). The relationship between these factors and the desired outcome (making the home smoke-free) require further inspection.

There are some potential limitations to this study. It was not possible to ascertain how many smokers resided in each household in the OS data, however we were able to determine whether the respondent was a smoker and what smoking restrictions, if any, were in place in their household. Also, sample size limitations placed constraints on our ability to explore the prevalence of smoke-free homes by both year and social class and cigarette consumption and to detect significant differences in smoking abstinence between consecutive years when abstinence was assessed in several sub-populations of the sample.

The majority of smokers reported smoking abstinence when in a room with a child. Those within this group whose homes are not smoke-free represent a target group whereby further intervention should be utilised in an attempt to move these people outside. There is no evidence to date to suggest that those already implementing partial restrictions are

amenable to further change. The behavioural impact of interventions targeted at this group should be compared with the behavioural impact of interventions focused on those with no current smoking restrictions in the home in order to answer the question of whether those with partial restrictions are more likely to implement full restrictions. However, while this group represents an obvious target for future interventions, this group will include those who are physically unable to smoke outside due to contextual or environmental constraints (i.e. child supervision, high-rise flats) and this must be taken into consideration when targeting this population in any future interventions.

However, nearly 40% of smokers living with children in a smoking household did not report smoking abstinence when in a room with a child. These smokers form a group of smokers that are hard to reach but who require intervention the most. Further research is required to further understand the barriers to modifying smoking behaviour in this hard-to-reach group in order to decide how best to proceed. Finding original ways to reduce child SHSe without resorting to further legislation to regulate private spaces remains a significant challenge for public health in England.

CHAPTER 4. CHILDREN'S EXPOSURE TO SECOND-HAND SMOKE IN THE HOME: A POST SMOKE-FREE ENGLAND

4.1 Introduction

In 2008, the year following the SFL in England, OS data suggested that overall, 30% of smokers had smoke-free homes increasing to 39% of smokers with children in the home (see chapter 3). Despite, 70% of smokers not keeping their home smoke-free, two-thirds of these reported that they refrained from smoking when in the same room as a child. These findings show that smokers' behaviour in the presence of others has changed considerably since the late 1990s when only approximately half of smokers living with children reported smoking abstinence when in a room with a child. However, the OS does not provide biological validation of these self-reported behaviours, so OS self-report data could not be used to test the assumption that self-reported smoking abstinence when in a room with children is associated with reduced children's cotinine levels.

The HSE collects biological samples, including saliva in which cotinine can be measured. Since 2007, the HSE has also measured where in the home parents smoke. Comparable to the assumption that refraining from smoking when in the same room as a child might have an impact on children's cotinine levels, those children whose parents limit their smoking to certain rooms or a certain number of rooms in the home may also be expected to have lower cotinine levels than those children whose parents do not restrict their smoking in such ways (Johansson, et al., 2004; Wakefield, et al., 2000).

Measuring children's cotinine levels may also help validate the self-reported smoking behaviour of parents. Brunekreef et al (2000) found agreement between nicotine in the air and parental self-reported smoking and a later study by Hovell et al (2009) which found that children's cotinine concentrations were relatively well matched to parental self-report of children's exposure. Information on where parents smoke in the home and where children are most exposed to SHS could further the contributions of chapter 3 and provide further evidence for the public health debate on how best to achieve smoke-free homes and target future interventions.

We know that children are still exposed to SHS, particularly children of smokers (Chapter 3). We know household level, area level and individual level characteristics of the child have previously been found to be predictive of SHSe, but we do not know at which level

predictors are most important (Section 2.3). Do household influences on children's SHSe outweigh influences of individual and area level characteristics? If they do, then we should be looking at ways of reducing cotinine levels in children with smoking parents, by changing modifiable characteristics at the household level. Therefore, in this chapter, children's cotinine levels are explored using a multilevel model in order to assess the importance of individual, household and area level factors to children's cotinine levels. The analysis is described in greater detail in the methods.

This chapter aims to determine the proportion of children who remain exposed to SHS by smoking parents post-SFL in 2008 and 2009 and assess their level of exposure using salivary cotinine measures. To build on the previous work on children's SHSe in chapter 3, this chapter explores where in the home parents are smoking and whether children's cotinine levels differ dependent upon where children's parents smoke. Then by fitting a multilevel model (which will include where parents smoke) it will be possible to specify at which level characteristics are most important in order to further reduce children's exposure to SHS in the home.

4.2 Methods

4.2.1 Sample

HSE data were used for this analysis of children's cotinine levels. The HSE is a nationally representative annual survey which is designed to provide information on England's health and health-related behaviours. The HSE aims to be representative of the English population in terms of age, gender, geographical location and socioeconomic status (DH, n.d) The sample is obtained each year using a clustered, stratified, multistage design which starts with a random selection of postal sectors (known as primary sampling units; PSUs) selected with probability proportional to their number of addresses. In order to maximise precision of the sample, PSUs were stratified before selection by two variables: local authority and proportion of households in the 2001 Census with a head of household with a non-manual occupation. Within each PSU, a random sample of addresses is taken.

Interviews are conducted with all adults and up to two children in each selected household. Respondents are asked to receive a nurse visit one week later where, amongst other biological measures, saliva samples are collected. In 2008 and 2009, approximately 65% of

eligible households took part, with 93% of children in these households interviewed, 66% seeing the nurse and 57% giving a saliva sample. With both 2008 and 2009 combined, there were 4,531 children aged 0-15 years. Cotinine is only collected in the HSE for respondents aged 4 years and above. Among the children aged 4-15 years, 1,937 (43%) had a valid cotinine level.

4.2.2 Measures

The HSE determines parental smoking status by whether parents answered 'yes' to the question 'Do you smoke cigarettes at all nowadays?' Since 2007, current smokers were asked where they smoked; if they reported that they smoked at home they were subsequently asked where in the home they smoked. Options included: kitchen, living room, dining room, bathroom, toilet, bedroom, study, everywhere, or on the doorstep or in the garden.

To explore children's SHSe (cotinine levels) by where their parents smoked, it was necessary to distinguish between those children whose parents smoked exclusively outside in the garden and those who smoked indoors. Those who smoke on the doorstep and those who smoke in the garden are recorded as one category in the HSE. However, as arguably smoking on the doorstep still amounts to smoking indoors, garden smokers needed to be distinguished from doorstep smokers. Smokers who reported that they only smoked on the doorstep or in the garden but who also reported that smoking occurred in their home on most days were excluded from the analysis, as these individuals conceivably correctly recognised that smoking on the doorstep was still indoor smoking. Of course, there are other reasons why someone might report smoking exclusively in the garden or on the doorstep and simultaneously report that smoking occurs in their home on most days. Smokers may have falsely reported that they smoked exclusively in the garden, or it may be that someone else other than a parent smoked indoors on most days. Regardless of the reason, by removing these individuals from the analysis we were able to say with greater confidence that those who report smoking in the garden or on the doorstep are genuinely smoking in the garden[9]. Therefore, from this point forward this behaviour is reported as smoking in the garden.

[9] It is acknowledged that there may be smokers who smoke on the doorstep and do not realise that this is still indoor smoking and so report their homes as smoke-free (Robinson & Kirkcaldy, 2007),

4.2.2.1. *Proportion of children with smoking parents who smoke in the home*

Children were categorised into four groups relating to their parents' smoking status: no parent smokes, mother only smokes, father only smokes or, both parents smoke. Those children whose parents reported smoking in any room in the home were considered to be exposed to SHS in the home.

4.2.2.2. *Where in the home does smoking occur*

Children's parents indicated which rooms in the home they smoked in. For the analysis in this chapter parents were recorded as smoking either: away from the home entirely, in the garden, in one room only or, in two or more rooms.[10]

4.2.2.3. *Cotinine*

Cotinine samples were obtained from children using the drool method, whereby saliva was dribbled into a test tube. To measure the amount of cotinine in the saliva sample, high performance liquid chromatography coupled to tandem mass spectrometry with multiple reaction monitoring (LC-MS/MS) was utilised (Bernert, Jacob, Holiday et al, 2009). Using this method, it is possible to detect cotinine levels as low as 0.1ng/ml (Feyerabend & Russel, 1990).

4.2.3 Descriptive analysis

All descriptive analyses were conducted using the complex survey package of PASW 18 in order to adjust for the complex HSE survey design which uses clustering and stratification. Supplied weights were used to compensate for non-response in the individual interview, non-participation in the saliva sample and limiting the number of children interviewed in a household to two.

4.2.3.1. *Self-reported SHSe*

Descriptive exploratory analysis was used to determine the proportion of children aged 0 to 15 years of age who were exposed to SHS and where this exposure took place using self-

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however, the geometric mean cotinine is low for this group and so we have good reason to believe that they are telling the truth.

[10] For those children whose parents smoked in one room only, the sample was divided into those whose parent(s) smoked exclusively in one room and not outside and those whose parent(s) smoked both inside in one room and outside. There was no significant difference in children's geometric mean cotinine between these two conditions and so these categories were combined for the final analysis.

reported data from children's parents on where they smoked. A univariate logistic regression was used to determine whether child exposure to SHS in the home was more or less likely when, neither parent smoked (baseline reference group), mother only smoked, father only smoked or when both parents smoked. Three further univariate logistic regressions were fitted for children with smoking parents to determine whether children were more likely to be exposed in no rooms (yes/no), one room (yes/no), or two or more rooms (yes/no) in the home dependent upon which parents smoked. For these analyses, 'mother only smokes' was the baseline reference category.

4.2.3.2. Biologically validated SHSe

In addition to children's exposure as measured by parental self-reported smoking in the home, cotinine data were also used to measure children's SHSe for those children aged 4 and above.

The cotinine data were positively skewed as a result of a large number of undetectable values which were falsely recorded as zero. In order to reduce skewness and meet the assumptions of linear regression, the data were log transformed. The natural log of cotinine was calculated in two stages, first all 0 values were replaced with 0.05 which is half the detectable limit of 0.1ng/ml, and then the natural log of all the cotinine data were taken including those with a new value of 0.05. When measuring children's exposure using cotinine data it was necessary to remove those children with a cotinine level greater than 12ng/ml, the suggested cut off for active smoking (Jarvis et al, 2008) and thus these individuals were not included in any of the analyses where cotinine was the outcome measure. Two univariate linear regressions were used to detect any significant differences in children's geometric mean cotinine, firstly dependent upon which parents smoked and secondly, dependent upon where smoking took place. These predictors were later included in the adjusted multilevel analysis.

4.2.4 Multilevel analysis: Predictors of childhood cotinine for children with smoking parents

To take account of the clustered nature of the HSE data and to explore the variation in children's SHSe between clusters, a three level multilevel model (MLM) with children's log cotinine as the response was specified. Based on previous research it is conceivable that variation exists in cotinine levels between children within households, between households

within areas and between areas. Specifying a MLM allows the observed variation in child cotinine to be partitioned into each of these three levels and compared with one another (Rice, Carr-Hill, Dixon, & Sutton, 1998). By using this method, any variation in cotinine remaining after taking account of all of the specified predictors is apportioned to the appropriate level by including the levels as random effects in the model. Levels of the MLM were specified using the PSU to represent areas and household serial number to represent households.

The HSE sampling design, described earlier in this section, involves selecting PSUs with a probability that is proportional to the total number of addresses within that PSU. If these sample selection probabilities are related to the outcome (i.e. log cotinine levels) even after adjusting for all covariates in the model, then the parameter estimates in a standard MLM may be biased. Weighting procedures that are used to correct for this bias (Pfeffermann, Skinner, Holmes, Goldstein, & Rasbash, 1998; Rabe-Hesketh & Skrondal, 2006) cannot be used as information on PSU selection probabilities are not available from the HSE for confidentiality reasons. In order to adjust for this potential bias we can use proxy indicators as covariates in the model. In this case, an indicator of geographical location was used (Urban/Rural).

The variables included at each level in the MLM, which were used to explore the cotinine levels of children with smoking parents, are specified in Table 6. Two covariates were included to take into account the sampling design strata which were created using LA and social class: region (North-South) was used as a covariate in the model instead of LA because LA is not provided in the publically available dataset and smoking prevalence is higher in the North compared to the South of England (Amos, et al., 2011). Education is included instead of social class because these two variables were highly correlated and the Akaike Information Criterion value (which assesses the goodness of fit of statistical models) for the final model was better with social class removed compared to when education was removed. The addition of social class into the model did not significantly improve the model fit.

To adjust for the unequal probability of selection and non-response, a weighting variable provided by the HSE could be used. To assess whether this was necessary the AIC from two MLM analyses were compared. One model without any weighting at all (unweighted model) and another with the weighting variable included as a covariate and interaction

terms between the weighting variable and all other covariates (Weighted model; DuMouchel & Duncan, 1983; Winship & Radbill, 1994) The AIC value was lowest (indicated the best model fit) when the weighting variable was not included. As the weighted model did not improve the fit compared with the unweighted model, it was decided not to use the weighting variable in the MLM.

Table 6 Covariates included in the multilevel model used to predict log cotinine of non-smoking children with smoking parents

Level	Level indicators	Predictors
Individual	Individual serial number	Sex
		Age group of child
Household	Household serial number	Parental smoking status
		Where parents smoke
		Dwelling type
		Highest level of education in the household
Area	Primary Sampling Unit	Region
		Urban/rural

Three models were specified: baseline (which is an intercept only model with just three level indicators included as random effects and geographical location to account for potential bias because of the unequal probability of selection of PSU), the final model which includes the individual level, household level and area level predictors listed in Table 6. The baseline model partitions variation in children's cotinine levels between that attributable to individuals within households, households within areas and areas to see whether household influences on cotinine outweigh influences of individual and area level characteristics. The final model estimates whether the predictors influence children's cotinine. The remaining unexplained variation in children's cotinine is partitioned between the 3 levels and is compared with the variance components in the baseline model. Finally, a third model was specified to assess whether where a parent smokes strongly influences children's cotinine. Model 3 is the final model with the household level predictor 'where parents smoke' removed.

4.3 Results

After removal of those who reported smoking on the doorstep or outside whilst simultaneously maintaining a smoke-free home (*N* =89), there were 4531 children under the age of 16 in the total sample. The sample was relatively evenly split between gender

and the three age categories (Table 7); over 40% came from households of managerial or professional occupation with at least one parent with a higher level of education. The sample came predominantly from urban areas. The sample size in 2009 was only a third of the sample size in 2008. In 2008 and 2009 combined, 28.4% of children lived with at least one smoking parent. Compared to the total sample, the sample of children with at least one smoking parent was more deprived. The proportion of children living in households of part or unskilled occupation was 29.1% compared to 19.2% in the sample of all children. Similarly, 9.2% of the child sample with at least one smoking parent lived in a detached home compared to 22.7% of the sample of all children. Of the 28.4% of the total child sample who lived with at least one smoking parent, 48.9% of children lived with a mother that was the only smoking parent, 30.2% lived with a smoking father and 20.9% lived with two smoking parents (Table 7). Not all smoking parents smoked in the home. Just under half of children with at least one smoking parent, had parent(s) that self-reported that they smoked inside the home. Therefore, just over half were not exposed to SHS in the home. There was a dose-response relationship between proxy indicators of socio-economic status and the prevalence of smoking in the home (For example, 6.1% of children with a smoking parent in the managerial and professional occupational group were exposed to SHS in the home compared to 27.1% in the part-skilled and unskilled occupational group). A greater proportion of those children living in households of lower social class, lower level of education and poorer housing, indicated by dwelling type, were exposed to parental SHS in the home. Of the 1288 children with at least one smoking parent and 510 (~40%) of these children had a valid cotinine measures (*N* = 24 were removed as they had cotinine levels synonymous with active smoking). Of these children, 54% lived with a smoking mother only, 28% lived with a smoking father only and the remainder (17%) lived with 2 parents that smoked.

4.3.1 Descriptive analysis

4.3.1.1. Children's SHSe according to parental self-reported smoking

Prevalence of smoking inside the home was highest for those children with smoking mothers only (58.7%; Table 7). There were no significant differences in home smoking prevalence between children with smoking mothers only and children with two smoking parents (53.4%; OR 0.81 p=.21), but there was a significant difference in home smoking prevalence between those children with smoking mothers only compared to children with smoking fathers only (30.6%; OR 0.31 p<.001) with fathers being significantly less likely to

smoke indoors. In addition to measuring the proportion of children that were exposed to SHS in the home, it was possible to determine where children's parents smoked and therefore, where children were likely to be exposed. Half of children with smoking parents were not exposed to SHS in the home as 37.0% of children's parents smoked in the garden and a further 13.4% smoked away from the home altogether (Table 8). A further 29.3% were exposed in one room only and 20.0% were exposed in at least two rooms. A significantly greater proportion of children were exposed to SHS in one room when they had a smoking mother compared to those who had a smoking father only (36.1% versus 19.7%, OR 0.45, p<.001) or those with two smoking parents (36.1% versus 25.0%, OR 0.55, p<.001). Children with smoking fathers or two smoking parents were more likely to have parents who smoked in the garden compared to children with smoking mothers (Father OR 2.14, p<.001; two parents OR 1.66, p<.01). For children with two smoking parents, 40.7% had parents that smoked in the garden compared to only 30.0% of children with smoking mothers; however, children with two smoking parents were less likely than children with smoking mothers to have parents that smoked away from the home completely (OR 0.43, p<.01). On balance, the proportions of children with smoking mothers only and two smoking parents that were exposed to SHS in the home were very similar, with 54.0% and 58.2% of children respectively being exposed to their parents' cigarette smoke indoors, with the least exposure occurring for children with smoking fathers only.

4.3.1.2. Children's SHSe measured by geometric mean cotinine

4.3.1.2.1. Parent smoking status

Geometric mean cotinine for all children was 0.19ng/ml (95% CI 0.18-0.21ng/ml) falling to 0.11ng/ml (95% CI 0.10-0.11ng/ml) for those children living with non-smoking parents (Table 9). Geometric mean cotinine of children with smoking mothers (0.95ng/ml, 95% CI 0.85-1.07ng/ml), was 2.4 times greater than that of children with smoking fathers (0.39ng/ml, 95% CI 0.34-0.44ng/ml; p<.001). Whereas, children with two smoking parents (0.90ng/ml, 95% CI 0.85-0.95ng/ml) had a similar level of exposure to children with a smoking mother only.

Table 7 Socio-demographic characteristics of children aged 0-15 years and the proportion of children who are exposed to SHS in the home by their parents (2008-09)

	All children		Children with smoking parents		
Socio-demographics	N	%	N	%	At least one parent smokes in the home*
Individual					
Gender					
Boy	2274	51.2	651	52.0	14.0
Girl	2257	48.8	637	48.0	13.9
Age group					
0-5 years	1707	37.5	483	36.5	9.7
6-10 years	1413	29.9	438	32.9	16.0
11-15 years	1411	32.6	367	30.4	16.8
Household					
Parental smoking status					
Neither	2250	55.4	-	-	-
Mother only†	679	13.9	679	48.9	58.7
Father only†	361	8.6	361	30.2	30.6
Both	248	5.9	248	20.9	53.4
At least one smoker	*1288*	*28.4*	*1288*	*100.0*	*49.8*
Smoking in the household					
Yes	785	17.4	622	48.1	73.9
No	3744	82.6	666	51.9	1..3
Social class					
Professional and managerial	1941	44.3	322	25.9	6.1
Skilled manual and non-manual	1585	36.5	552	45.0	15.8
Part skilled and unskilled	823	19.2	350	29.1	27.1
Dwelling type					
Detached	1066	22.7	118	9.2	4.2
Semi	1541	33.2	463	35.6	15.4
Terraced	1579	36.0	589	45.5	17.8
Flat	341	8.2	116	9.7	17.5
Education					
Degree or equivalent	2053	45.4	361	28.8	5.5
A level or equivalent	2091	45.9	747	57.7	19.2
GCSE or equivalent & below	391	8.6	175	13.6	30.5
Year					
2008	3401	77.9	1001	80.2	14.6
2009	1130	22.1	287	19.8	11.4
Area					
Location					
Urban	3625	81.0	1087	84.4	14.8
Fringe	453	9.3	105	7.8	9.4
Rural	453	9.7	96	7.8	10.5
Region of England					
North	2223	45.4	688	49.9	16.9
South	2308	54.6	600	50.1	11.4
	4531		**1288**		

† Includes children whose parents live in single or two parent households * Either mother only smokes, father only smokes or both parents smoke in the household. $ Logistic regression analysis was conducted to test for differences in home smoking prevalence by parental smoking.

Table 8 Percentage of children with parents that smoke in and outside the home and four logistic regression analyses predicting smoking in each location by parental smoking status

Children's parents smoke…	…away from the home	…in the garden	…in 1 room	…in 2 or more rooms	Total
Mother only smokes (%)†	11.5	30.0	36.1	22.1	679
Father only smokes (%)†	22.7	47.4	19.7	9.7	361
Both parents smoke (%)	5.2	40.7	25.0	29.0	248
Total (%)	**13.4**	**37.0**	**29.3**	**20.0**	**1288**
Logistic regression					
Mother only smokes	1.00	1.00	1.00	1.00	
Father only smokes (OR)	2.13***	2.14***	0.45***	0.39***	
	(1.58-2.87)	(1.19-2.33)	(0.33-0.63)	(0.27-0.57)	
Both smoke (OR)	0.43**	1.66**	0.55***	1.43	
	(0.23-0.81)	(1.65-2.78)	(0.39-0.79)	(0.96-2.14)	

† Includes children whose parents live in single or two parent households. The OR represents a multiplicative change in the outcome compared with the reference category. ** p<.01 *** p<.001

4.3.1.2.2. Where smoking occurred

There was a dose-response relationship between geometric mean cotinine and where children's parents smoked. When all children were grouped together, cotinine levels were 7.6 times lower when parents smoked away from the home compared to when smoking occurred in two or more rooms in the home (p<.001)[11]. This dose-response relationship was found for children with smoking mothers only, smoking fathers only and two smoking parents.

Compared to children whose father's smoked exclusively in the garden, when children's mothers reported smoking exclusively in the garden, children's geometric mean cotinine was 1.6 times higher (0.35ng/ml compared to 0.22ng/ml respectively, p<.001). There was no significant difference between children with smoking mothers only and those with two smoking parents who both smoked in the garden. Children's cotinine levels were similar regardless of whether their mother only, father only, or both parents smoked in one room only in the home. Similarly, there was no significant difference in children's geometric mean cotinine levels between children parent smoking status groups who all smoked in two or more rooms in the home.

[11] Unadjusted linear regression using 2 or more rooms as a reference category found that child geometric mean cotinine declined as smoking in the home reduced.

Table 9 Children's geometric mean cotinine dependent upon which parents smoke in the home and where they smoke (N=1,737)

	Child lives with…									
	…non-smoking parents		…a mother that smokes†		…a father that smokes†		…two smoking parents		…at least one parent that smokes	
	N		*N*	Geometric mean cotinine	*N*	Geometric mean cotinine	*N*	Geometric mean cotinine	*N*	Geometric mean cotinine
Away from the home	-	-	25	0.53 (0.21-1.37)	30	0.25 (0.16-0.39)	3	¤	58	0.31 (0.24-0.40)
Outside in the garden	-	-	82	0.35 (0.29-0.41)	66	0.22 (0.19-0.25)	31	0.39 (0.37-0.41)	179	0.30 (0.27-0.32)
In one room	-	-	104	1.21 (1.06-1.39)	31	0.81 (0.40-1.63)	24	1.36 (1.21-1.53)	159	1.13 (1.05-1.22)
In two or more rooms	-	-	66	2.45 (1.00-5.87)	18	2.01 (0.76-5.28)	30	2.45 (1.63-3.68)	114	2.36 (2.08-2.68)
Total **s**moke in home	-	-	170	1.61 (1.32-1.95)	49	1.13 (0.63-2.02)	54	1.89 (1.46-2.44)	273	1.55 (1.31-1.85)
All	1196	0.11 (0.10-.011)	277	0.95 (0.85-1.07)	145	0.39 (0.34-0.44)	88	0.90 (0.85-0.95)	510	0.72 (0.61-0.85)

†Includes children whose parents live in single or multiple parent households. ¤ Sample too small to compute a reliable estimate.

4.3.2 Multilevel predictors of children's geometric mean cotinine

4.3.2.1. Random effects

4.3.2.1.1. Basic model

When only level specification variables (PSU and household) were included in the model, the majority of the variance in children's geometric mean cotinine was attributed to differences between households within PSUs (61%), thus indicating that household level factors may be very influential in determining children's cotinine levels. A further 25% of the variance occurred between individual children the other 14% of the variance was attributed to area level effects.

4.3.2.1.2. Final model (with all predictors included)

When all predictors were added to the basic model, the unexplained variance at the household level decreased by 43% and at the area level by 88%.

4.3.2.1.1. Final model (with 'where parents smoke' removed)

When all predictors were added to the basic model except where parental smoking occurs, the unexplained variance at the household level decreased by 22% and at the area level by 36% in comparison to the basic model. Therefore, the addition of the predictor where parents smoke explains the same amount of variation at the household and area level as all the other predictors combined.

4.3.2.2. Fixed effects

***Individual characteristics**:* Children's geometric mean cotinine was not significantly associated with children's gender. Children aged 6-10 years had significantly lower geometric mean cotinine than children aged 4-5, but there was no significant difference between those aged 11-15 and the baseline (4-5 year olds). ***Household characteristics**:* Children's cotinine concentrations varied by which of their parents smoked. Compared to children with two smoking parents, those whose father only smoked were significantly less exposed. There was no significant difference in exposure between children with two smoking parents and a smoking mother only. There was a dose-response relationship between where parents smoked and children's geometric mean cotinine (Figure 9). Children whose parents smoked in two or more rooms had geometric mean cotinine concentrations 6.54 times higher than those whose parents smoked in the garden, as did

those who had parents who smoked in one room, but to a lesser magnitude (3.34 times) compared to those where parental smoking occurred in the garden only. There was no significant difference in childhood geometric mean cotinine concentrations between those children whose parents smoked away from the home and those whose parents smoked in the garden only. There was a dose-response relationship between dwelling type and geometric mean cotinine, with children living in terraced housing having geometric mean cotinine concentrations 1.93 times higher than those living in detached homes. Similarly, children living in flats had geometric mean cotinine concentrations 1.82 times higher than those living in detached households. There was no significant difference in geometric mean cotinine concentrations between children living in semi-detached homes and detached homes. Lower educational status predicted higher geometric mean cotinine whereby children living in households where adults had no qualifications had geometric mean cotinine concentrations 1.86 times higher than those living in households with at least one adult with a higher education or degree level qualification. ***Area level characteristics****:* There was no significant difference in child geometric mean cotinine concentrations dependent on whether the child lived in urban compared to urban fringe or rural areas. Similarly, there was no significant difference in childhood geometric mean cotinine concentrations when they lived in the South of England compared to the North.

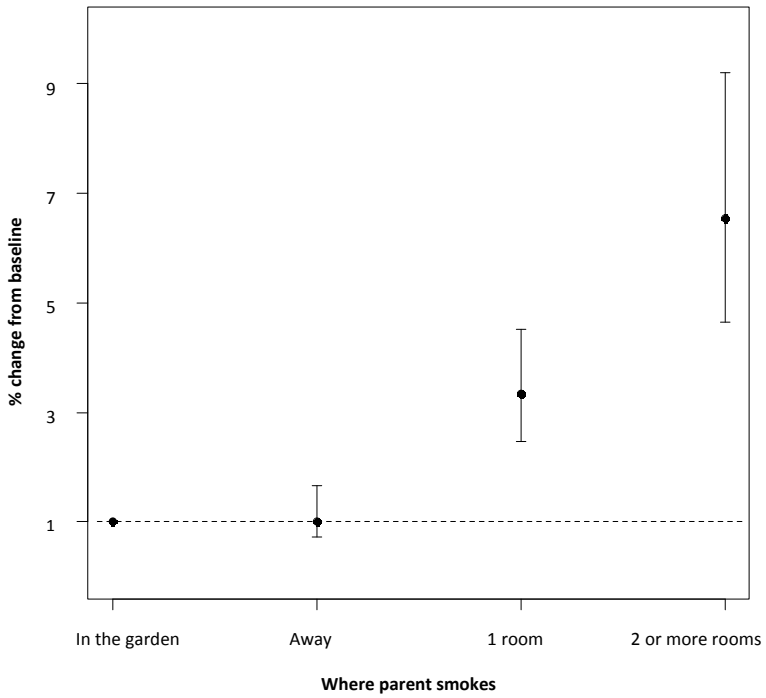


Figure 9 Relationship between where parents' smoke and children's' cotinine levels (ML regression analysis)

Table 10 Multilevel modelling of children's SHSe (2008-9)

	Basic model		Final model		Final model with 'where parents smoke' excluded	
Variable	Estimate	SE	Estimate	SE	Estimate	SE
Individual						
Gender						
Female			1.00		1.00	
Male			0.94	0.09	0.91	0.11
Age group						
4-5 years			1.00		1.00	
6-10 years			0.72*	0.14	0.88	0.16
11-15 years			0.75	0.16	1.08	0.18
Household						
Smoking						
Both parents			1.00		1.00	
Mother only			0.83	0.16	0.75	0.20
Father only			0.63*	0.18	0.41***	0.22
Smoking occurs						
Garden			1.00		-	-
Away			1.01	0.21	-	-
In 1 room			3.34***	0.15	-	-
In 2+ rooms			6.54***	0.17	-	-
Dwelling type						
Detached			1.00		1.00	
Semi			1.31	0.21	1.68*	0.24
Terraced			1.93**	0.21	2.34**	0.25
Flat			1.82*	0.30	2.97**	0.35
Education						
Degree			1.00		1.00	
School level			1.26	0.14	1.80***	0.16
No quals			1.86**	0.22	3.08***	0.28
Area						
Location						
Urban	1.00		1.00		1.00	
Fringe	0.74	0.27	0.99	0.21	0.86	0.25
Rural	0.44**	0.29	0.74	0.23	0.69	0.28
Region						
North			1.00		1.00	
South			0.89	0.12	0.84	0.15
Random effects variance						
Level 1 (Individual)	**0.55**		**0.54**		**0.55**	
Level 2 (Household)	**1.33**		**0.76**		**1.04**	
Level 3 (Area)	**0.29**		**0.04**		**0.21**	

Est: Estimate; SE; Standard error. The estimates and standard errors are derived by exponentiating the regression coefficient and standard error from the multilevel model. The exponentiated regression coefficient describes a multiplicative change compared with the baseline category.

4.4 Discussion

4.4.1 Where are children exposed to SHS?

Nearly 30% of children in England live with smoking parents. However, according to the self-report of parents, 50% of these children are not exposed to SHS in the home and an

additional 29% of children have parents who self-report smoking in one room only. This suggests that the majority of parents are taking measures to limit the amount of tobacco smoke in their homes.

There was a strong dose-response relationship between where parents smoked and children's geometric mean cotinine levels. Children with parents who reported smoking in the garden or away from the home unsurprisingly had the lowest geometric mean cotinine levels. Children exposed to parental SHSe in one room only had significantly higher geometric mean cotinine concentrations than those whose parents smoked in the garden but they also had significantly lower levels than those children whose parents smoked in at least two rooms. Although, smoking in the garden or away from the home altogether must still be considered the gold standard and the most effective way to protect children from tobacco related harm, these findings suggest that parents who limit their smoking to one room only in the household are effectively reducing the cotinine levels of their children. Nevertheless there has been concern that using half-way measures to reduce children's SHSe may dissuade parents from taking further protective action such as making their home completely smoke-free (L. Hill, et al., 2003). If this assumption is correct then informing the public that limiting smoking to one room has some protective effect may discourage the implementation of smoke-free homes.

In general, cotinine levels were highest when children's mothers smoked and when both parents smoked and were significantly lower when father's only smoked. This difference in cotinine is explained mostly by the differences in where different parents smoked. For example, children with smoking fathers were less exposed inside the home as the vast majority of fathers (~70%) smoked outside the home (either in the garden or away from the home) compared to 42% of children having a smoking mother who only and 46% of children with two smoking parents. When children's fathers did smoke in the home, there was no significant difference in children's geometric mean cotinine compared to that of children with smoking mothers only and two parents that smoked in the home. However, children with smoking mothers who smoked in the garden had significantly higher cotinine than children with fathers or both parents who smoked outside. This inconsistency may be indicative of a number of scenarios. It may be the case that some mothers are falsely reporting that they smoke exclusively outdoors, or they may be smoking on the doorstep unaware that SHS still remains in the house or it might also be the case that their children stay in close proximity to them even when they smoke outside.

Overall, the fact that the majority of those who smoke indoors report smoking in one room only suggests the further denormalisation of smoking behaviour and an increase in the perception that exposing others to tobacco smoke is inappropriate. Nevertheless, there are a number of children who remained highly exposed to SHS following the SFL in England.

4.4.2 Factors associated with high levels of exposure

Higher cotinine levels amongst children were associated with being between 4 and 5 years of age, parental smoking indoors and parents with a poor level of education, or where the mother or both parents smoke. Furthermore, children living in terraced housing or flats were more likely to have higher cotinine levels in comparison to those living in detached homes. Living in a flat still was still significantly associated with children's cotinine levels even when adjusting for where a parent smoked and the proxy indicator of social class, education. This suggests that living in a flat or a terraced house regardless of social class has a hindering effect on smoking outside. This may be due to lack of appropriate outdoor space either in terms of space or safety as suggested previously (Halterman, et al., 2007; L. Hill, et al., 2003; J. Robinson & Kirkcaldy, 2007a). The multilevel model findings suggested that those living in urban areas had higher cotinine levels than those living more rurally and those in the North having higher levels than those in the South. However, neither of these relationships was significant. This may be due to sample size limitations, although it is more likely that these area measures are explained by social class proxy predictors. For example, there is more deprivation in the North of England compared to the South and in urban areas compared to rural areas and this may have been captured by highest level of education and dwelling type in the model (Amos, et al., 2011).

4.4.3 How should interventions be targeted?

The results of the multilevel analysis revealed that household level factors, particularly, where in the home children's parents smoke, are the most important predictors of children's SHSe. Where parents smoked accounted for almost the same amount of the unexplained variance at the household level as all the other variables in the model combined. This is encouraging as where parents smoke is a modifiable factor that can be targeted for change. In accordance with the ecological approach a multilevel intervention

strategy might be the most effective way to change parental smoking behaviour in the home. This is discussed in greater detail in the conclusions (7.3).

4.4.4 Limitations

This analysis was limited by dataset coding. Firstly, smoking on the doorstep or in the garden was combined but smoking on the doorstep counts as indoor smoking if the door is open. Secondly, although we were able to determine where parents smoked, we were not able to determine whether children were present in the room when parents smoked. It is likely that if parents restrict smoking to certain rooms then they may be conscious of exposing their children and they may therefore abstain around children too. Furthermore, to simplify analysis we classified smoking restrictions as smoking in one room or two rooms and we did not use information about which rooms were smoked in. Therefore, it is unknown whether there is concordance between where two smokers smoke in two parent smoking households. If both parents limited their smoking to one room only but this was different for each parent then this might be expected to have an impact on children's cotinine levels.

Had the sample size been larger, it might have been possible to explore interactions between some of the predictor variables. For example the relationship between dwelling type and number of rooms smoked in. Flats are more likely to be open plan and therefore smoking in one room may produce higher cotinine levels in children than smoking in one room in a detached home. It would also been of interest to explore the interaction between where parents smoked and which parent(s) smoked and their variable impact on children's' cotinine levels. The same is true of cigarette consumption; someone that smokes heavily in one room compared to someone who smokes lightly in more than one room may have a differential impact on children's cotinine level.

Given that this chapter shows that the strongest predictor of SHSe in children with smoking parents, is where their parents smoke, there is a real need to influence the mechanisms which may motivate parents to go outside.

CHAPTER 5. ASSESSING THE KNOWLEDGE OF THE POTENTIAL HARM TO OTHERS CAUSED BY SECOND-HAND SMOKE: DO MASS MEDIA CAMPAIGNS INFLUENCE KNOWLEDGE AND PROTECTIVE BEHAVIOURS IN THE HOME?

5.1 Introduction

People's specific knowledge of the impacts of SHS, how this might have changed over time and the role that this knowledge might play in smoking practices in England has not been explored before. It has been suggested that smokers' concerns about harming others is a motivating factor in quit attempts (Jamieson, 1999).For those smokers who are unable to or unwilling to quit, concerns about the dangers and decreased social acceptability of smoking may influence smokers to take measures to protect others from their smoke, as was found to be the case in Queensland, Australia and the USA (Dunn, et al., 2008; Gilpin, et al., 1999; Phillips, et al., 2007). It may be the case that smokers' unrealistic optimism is juxtaposed by their concern about the impact of their smoking on others (Weinstein, 2001). Indeed a phenomenon known as the 'third person effect' suggests that people often discount the personal effects of harmful environments and at the same time recognise the risks to others (Davidson, 1983). However, results from a small-scale US study conducted with children with asthma found that although many parents were aware that their smoking exacerbated the symptoms of their children's asthma, only 33% of these smokers reported having a smoke-free home (Mahabee-Gittens, 2002). Similarly, a UK study found that 85% of parents from smoking households believed that smoking affects children's health, yet only 30% prohibited smoking in the house. However, 65% of these parents did report other measures that they believed protected against SHSe, e.g. opening a window or not smoking in the same room with a child (Blackburn, et al., 2003). As outlined in the background section in Chapter 2 (2.3.10), recent research has suggested that smokers are confused about the specific impacts of SHS and the efficacy of the half-way protective measures that they take (Jones, et al., 2011). The authors suggest that mass media campaigns could be used to eliminate confusion.

In 2003, debate surrounding the issue of SFL started in earnest and was highly publicised in the media as a result. In the same year, a Government-funded TV, radio, printed press and billboard campaign on the effect of SHSe on children's health, titled 'If you smoke, I smoke' was launched. Anti-SHS mass media campaigns ran frequently between December 2003 and April 2007 (Arnott, Dockrell, Sandford, & Willmore, 2007). Thereafter, Government campaigns focused on compliance with SFL. Action for Smoking and Health (ASH)

monitored their personal media coverage and noted it was at its highest between March 2004 and February 2006, with stories mentioning ASH England reaching an average audience of 4.5 million people a week (Arnott, et al., 2007).

Evidence suggests that media coverage of debates over smoke-free policies and SHS mass media health promotion campaigns help disseminate the implicit message that SHS exposure is unacceptable (Borland, et al., 1999), as would removing smoking from public places. Furthermore, increased awareness of the issue, may influence attitudes towards smoking and alter social norms with regards to smoking indoors and smoking when children are present and therefore influence subsequent smoking behaviours in the home.

In the absence of any quantitative evidence on the link between knowledge and SHS-related behaviours in England, this chapter aims to quantify the levels of and trends in knowledge of SHS-related illnesses in England, the predictors of this knowledge and, in turn, to assess whether knowledge is associated with SHS-protective behaviours.

5.2 Methods

5.2.1 Data

The OS is described in detail in chapter 3. In addition to questions about home smoking rules, the OS also asks respondents several questions about SHS-related illness.

5.2.2 Outcome measures

Knowledge: Respondents were asked 10 questions about their knowledge of SHS-related illnesses, 5 about illnesses in children and 5 about illnesses in adults. 'Do you think that living with someone who smokes does, or does not, increase a child's risk of: asthma/ear infection/cot death/chest infections/other infections?' and 'Do you think that breathing in someone else's smoke increases the risk of a non-smoker getting: asthma/lung cancer/heart disease/bronchitis/coughs and colds?' Response options are 'increases risk' or 'does not increase risk' of each illness.

SHS-protective behaviour: Since 2006, the OS asked all respondents to describe their home smoking policy: smoking is not allowed at all, smoking is allowed in some rooms or at some

times, smoking is allowed everywhere or don't know. In the analyses for this chapter a smoke-free home describes a household where smoking is not allowed at all.

Since 1997, 'smokers only' have been asked about their smoking behaviour when in a room with a child; whether they smoke the same number of cigarettes as usual, smoke fewer, do not smoke at all or other. Smokers are asked regardless of whether they report a smoke-free home as it does not only refer to smoking within their own home.

5.2.3 Analyses

The levels of and trends (1996-2008) in knowledge of SHS-related illnesses were examined before a composite knowledge score by giving one point for every correctly identified illness. As knowledge of respiratory illnesses is relatively common (Klesges, et al., 1988) and many of the questions asked were about respiratory illnesses, a total score of 8-10 was taken to indicate good knowledge.

To determine the predictors of good knowledge and SHS-protective behaviours, the data were analysed using univariate and multivariate regression, with adjustments made for the OS complex sampling design. A weighting factor was applied to correct for unequal probability of selection.

The predictor variables included were age group, gender, smoking status, social class, number of cars owned, number of adults in the household and age of youngest child. To evaluate changes over time and to crudely assess whether mass media campaigns have impacted on knowledge or SHS-protective behaviours, three time periods were created, 1996-2002 (pre-SHS-media campaigns), 2003-2006 (during SHS-media campaigns) and 2007-2008 (post SFL). Although one campaign on the impacts of SHS ran between March and April 2007, from then until July 2007 the campaigns focused on explaining compliance with legislation. No SHS-mass media campaigns were run in 2008.

The predictive ability of each model was assessed using predicted probabilities to compute the receiver operating characteristic. A value of 1 represents perfect predictive fit, whereas 0.5 means the model is synonymous with a random guess (Hosmer & Lemeshow, 2000). An area under the curve (AUC) value of 0.7 is representative of a good fit (Field, 2005).

The SHS-protective behaviour analyses included knowledge of SHS-related illnesses and attitudes towards restrictions in three public places. A composite score of 0-3 was created for agreement with smoking restrictions in pubs, restaurants and workplaces.

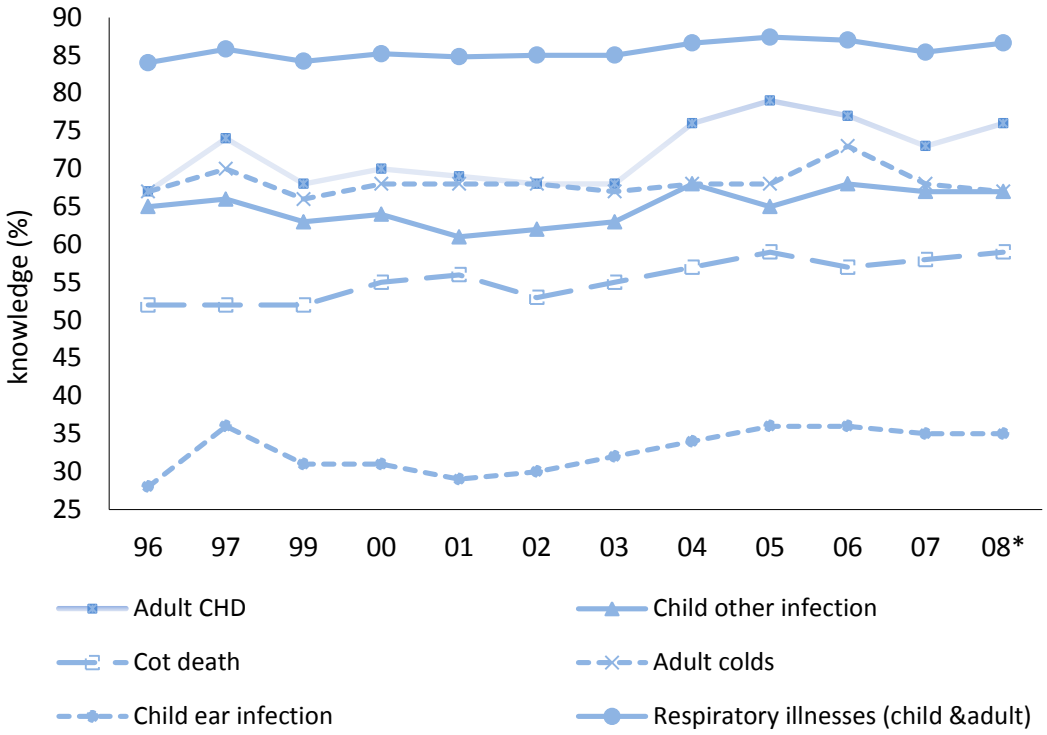
5.3 Results

The sample distribution for gender and age for each annual sample are consistent with national population estimates (Office of National Statistics). A total sample of 32 630 respondents was obtained across the 12-year period (Table 3). Approximately 50% of respondents had never smoked, 27% were ex-smokers and 24% were current smokers (17% light and 7% heavy smokers). Examining annual smoking prevalence rates showed that, in line with other national surveys (Robinson & Lader, 2009), smoking prevalence decreased from 28% in 1996 to 21% in 2007.

5.3.1 Levels of and trends in knowledge of SHS-related illnesses

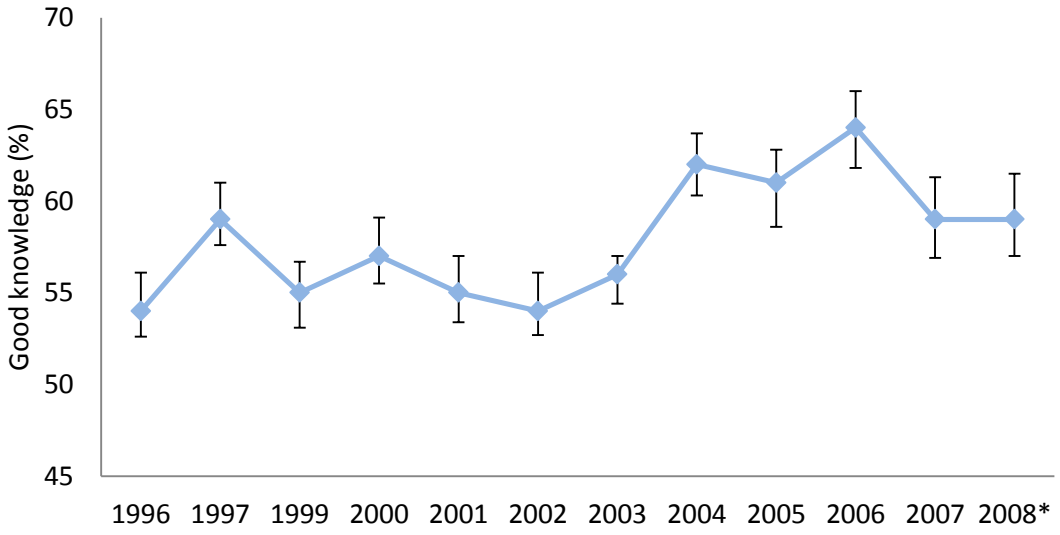
Overall, more than 80% of respondents knew that SHS causes respiratory illnesses (Figure. 10) but fewer were aware of the role of SHS in cot death (55%) and other infections (64%) in children and the links to coronary heart disease (71%) and coughs and colds in adults (68%). Knowledge of childhood ear infections was particularly poor (33%). There was a small increase in this knowledge between 1996 and 2008 for cot death (6%). Using the composite score it was clear that knowledge increased from 1996 (Figure. 11). The most marked increase was between 2003 and 2004 from 56% (95% CI 54.4-57.0%) to 63% (95% CI 60.3-63.7%). The highest level of knowledge was reached in 2006 (64%) but this fell significantly to 59% in 2007, and remained constant in 2008.

A higher proportion of never smokers had good knowledge (65%, 95% CI 64.0-65.5%) compared with ex-smokers (59%, 58.1-60.1%), light smokers (46%, 95% CI 44.6-47.2%) and heavy (34%, 95% CI 31.9-35.8%) smokers. Unfortunately, the trend data for each subgroup are not reliable due to sample size limitations.



*2008 data were collected in February and March 2009 due to a sampling error in 2008

Figure 10 Trends in all respondents' knowledge of SHS-related illnesses



*2008 data were collected in February and March 2009 due to a sampling error in 2008

Figure 11 Trends in the percentage of respondents with good knowledge of SHS-related illnesses

5.3.2 Predictors of good knowledge

Adjusted multivariate logistic regression found age, gender, social class, smoking status, number of adults in the household, having a child under 16 in household and time period, all independently predicted knowledge (Table 11). Odds of good knowledge were highest for 25- to 44-year-olds (OR: 1.20, 95% CI 1.12-1.29) compared with 45- to 64-year-olds and for those of managerial and professional occupations (OR: 1.09, 95% CI 1.03-1.16) compared with those of skilled occupation. Heavy (OR: 0.28, 95% CI 0.25-0.31), light (OR: 0.45, 95% CI 0.42-0.48) and ex-smokers (OR: 0.86, 95% CI 0.81-0.92) were all less likely to have good knowledge than never smokers. The presence of children in the household increased the odds of good knowledge (OR: 1.24, 95% CI 1.16-1.33) compared with households with no children, whereas those living in households with three or more adults had lower odds (OR: 0.89, 95% CI 0.83-0.96) compared with households with two adults. Odds of good knowledge were lower in 1996-2002 compared with 2003-06 (OR: 0.85, 95% CI 0.80-0.90). There was no significant difference in the odds of good knowledge between 2007 and 2008 and between 2003 and 2006. The AUC value testing the predictive ability of the model was 0.63, $p<0.05$, suggesting that the model was unable to fully explain all the variation in knowledge.

Table 11 Logistic regression predicting 'good' knowledge (1996-2008)

Predictor variables	*N*	Good knowledge (%)	Univariate		Multivariate	
			OR	95% CI	OR	95% CI
Gender						
Female	16 721	59	1.00		1.00	
Male	13 641	56	0.87***	0.83-0.92	0.90***	0.86-0.95
Age (years)						
45-64	9721	57	1.00		1.00	
16-24	1936	57	1.03	0.94-1.13	1.05	0.94-1.18
25-44	11 035	62	1.27***	1.20-1.35	1.20***	1.12-1.29
65+	7670	52	0.82***	0.77-0.88	0.77***	0.72-0.83
Social Class						
Manual & non-manual	13 237	57	1.00		1.00	
Managerial & professional	10 583	61	1.21***	1.15-1.28	1.09**	1.03-1.16
Part & unskilled	6542	53	0.86***	0.80-0.92	0.93*	0.87-1.00
Number of cars						
1	13 754	57	1.00			
0	7117	52	0.80***	0.75-0.85	0.96	0.89-1.03
2+	9491	61	1.17***	1.12-1.24	1.03	0.96-1.09

Predictor variables continued…	*N*	Good knowledge (%)	Univariate	Multivariate		
			OR	95% CI	OR	95% CI
Smoking status						
Never	13 937	65	1.00		1.00	
Ex	8811	59	0.79***	0.75-0.84	0.86***	0.81-0.92
Light	5375	46	0.46***	0.43-0.49	0.45***	0.42-0.48
Heavy	2239	34	0.28***	0.25-0.31	0.28***	0.25-0.31
Adults in household						
2	16 323	59	1.00		1.00	
1	9804	54	0.80***	0.76-0.84	0.96	0.91-1.03
3+	4235	57	0.90 **	0.84-0.96	0.89**	0.83-0.96
Child in the household						
No child <16	21 930	55	1.00		1.00	
<16 years	8432	63	1.39***	1.32-1.47	1.24***	1.16-1.33
Year						
2003-2006	9392	56	1.00		1.00	
1996-2002	17 510	60	0.83	0.79-0.88	0.85	0.80-0.90
2007-2008	3460	59	0.95	0.88-1.03	0.92	0.84-1.01

*p<.05, **p<.01, *** p<.001

5.3.3 SHS-protective behaviours

In 2008, the percentage of respondents with smoke-free homes was 72% (95% CI 69.4-73.6%); this was an 11% absolute increase since 2006. Amongst smokers, there was a smaller increase from 27% (95% CI 22.6-30.4%) to 30% (95% CI 25.0-34.7%) during the same period. Univariate analysis shows no significant increase between 2006 and 2007 and 2006 and 2008 (Table 13).

5.3.4 Knowledge and SHS-protective behaviours

The prevalence of smoke-free homes and smoking abstinence varied markedly with respondents' level of knowledge of SHS-related illnesses (Table 12).Of those respondents who know of 0-5 SHS-related illnesses, only 39% (95% CI 35.7-41.5%) had smoke-free homes, whereas 75% (95% CI 73.9-76.7%) of those with knowledge of 8-10 illnesses did. Similarly, amongst smokers, only 16% (95% CI 12.8-19.9%) with knowledge of 0-5 illnesses have smoke-free homes compared with 35% (95% CI 30.9-38.7%) of smokers with good knowledge.

Smoking abstinence when in a room with a child for those with knowledge of 0-5 illnesses was 56% (95% CI 54.2-58.1%), while for those who were aware of 8-10 illnesses was 74% (95% CI 72.8-76.0%).

Table 12 Relationship between knowledge of SHS-related illnesses and SHS-protective behaviours

Number of illnesses correctly identified	Percentage respondents (95% confidence intervals)		
	Smoke-Free home (2006-2008)		Smoking abstinence (1997-2008)
	All	Smokers only	A child
0-5	39 (35.7 – 41.5)	16 (12.8 – 19.9)	56 (54.2 - 58.1)
6-7	65 (62.5 – 68.0)	33 (27.4 – 38.7)	72 (69.3 – 73.8)
8-10	75 (73.9 – 76.7)	35 (30.9 – 38.7)	74 (72.8 – 76.0)
Total	**66 (65.1 – 67.6)**	**28 (25.8 – 30.8)**	**67 (62.2 – 68.4)**

5.3.5 Predictors of smoke-free homes: the population as a whole

Adjusted multivariate analysis found that knowledge of SHS-related illnesses predicted smoke-free homes with odds increasing by 18% (95% CI 14-21%) for every unit increase in knowledge (Table 13). There was a significant increase in the prevalence of smoke-free homes between 2006 and 2007 (OR: 1.30, 95% CI 1.09-1.56) and between 2006 and 2008 (OR: 1.58, 95% CI 1.31-1.90). Respondents with part skilled or unskilled occupations and those with no car had poorer odds of having a smoke-free home (OR: 0.70, 95% CI 0.57-0.86 and OR: 0.64, 95% CI 0.53-0.78, respectively) compared with those of skilled occupation and those with one car. Heavy (OR: 0.09, 95% CI 0.06-0.13), light (OR: 0.18, 95% CI 0.14-0.22) and ex-smokers (OR: 0.81, 95% CI 0.68-0.97) all had lower odds of a smoke-free home than never smokers. Those with a child under the age of 5 had much greater odds of a smoke-free home (OR: 2.33, 95% CI 1.71-3.19) than those with no children under 16 years residing. Respondents' odds of a smoke-free home increased with each additional public place in which they agreed smoking restrictions were necessary (OR: 1.78, 95% CI 1.61-1.97). The AUC was 0.82, $p<0.05$, indicating that the model was a good fit of the data.

5.3.6 Predictors of smoke-free homes: smokers only

Odds of a smoke-free home increased by 10% (95% CI 4-16%) with every unit increase in knowledge. Smokers' odds also increased with agreement with restrictions in each additional public place. Heavy smokers had lower odds of having a smoke-free home (OR: 0.47, 95% CI 0.31-0.72) compared with light smokers, as did those with no car (OR; 0.47, 95% CI 0.30-0.75) compared with those with a car. Smokers with a child under 5 years had greater odds of a smoke-free home (OR: 2.96, 95% CI 1.77-4.96). The AUC was 0.74, $p<0.05$, again indicating a good model fit.

5.3.7 **Smokers'** abstinence in a room with a child

The odds of abstinence when in a room with children increased by 11% (95% CI 9-14%) for each unit increase in composite knowledge score (Table 14). The odds of abstinence were greater for each additional public place with a smoking ban that smokers' agreed with. Heavy smokers, compared with light smokers, respondents with a part-skilled or unskilled occupation, compared with those of skilled occupation, and those with no car, compared with those with a car, were less likely to abstain, whilst those with two or more cars and those of managerial or professional occupation were more likely to. Older smokers had greater odds of abstinence and those smokers living with children between the ages of 5 and 15 were more likely to be abstinent than those with no children. Interestingly, having infants (0-4 years) in the household was significantly associated with being less likely to abstain in a room with children than those with no children. The number of adults residing and the gender of the smoker were not significant predictors of abstinence when in a room with a child. Compared with the period 2003-06, the odds of abstinence in a room with a child were lower in 1996-2002 (OR: 0.85, 95% CI 0.74-0.97) but higher in 2007-2008 (OR: 1.77, 95% CI 1.40-2.24). The predictive model for abstinence with children was a good fit of the data (AUC= 0.71, $p<0.05$).

5.4 Discussion

To my knowledge, this quantitative study is the first in England to assess the trends in, and determinants of, knowledge of the specific illnesses related to SHS and to explore the relationship between knowledge and the implementation of SHS-protective behaviours

Table 13 Logistic regression predicting smoke-free home incidence for all respondents and smokers only (2006-2008)

	All respondents				Smokers only			
Predictors	*N*	Smoke-free(%)	Univariate OR	Multivariate OR	*N*	Smoke-free(%)	Univariate OR	Multivariate OR
Gender								
Female	2388	67	1.00	1.00	599	32	1.00	1.00
Male	2842	65	0.92 (0.82-1.04)	1.06 (0.91-1.24)	565	24	1.47 (1.19-1.94)**	1.39 (1.00-1.93)*
Age group (years)								
45-64	1872	66	1.00	1.00	396	25	1.00	1.00
16-24	264	59	0.74 (0.59-0.93)***	0.95 (0.65-1.38)	106	36	1.64 (1.06-2.55)**	0.97 (0.52-1.79)
25-44	1739	69	1.17 (1.01-1.35) *	1.08 (0.88-1.33)	477	31	1.33 (0.96-1.83)	0.77 (0.51-1.16)
65+	1416	66	1.01 (0.86-1.17)	1.09 (0.90-1.33)	185	16	0.59 (0.35-0.98)*	0.74 (0.41-1.35)
Social class								
Skilled manual & non-manual	2346	66	1.00	1.00	567	29	1.00	1.00
Managerial & Professional	1911	73	1.44 (1.25-1.66)***	0.98 (0.83-1.17)	290	33	1.23 (0.88-1.73)	0.96 (0.66-1.41)
Part & Unskilled	1034	55	0.63 (0.53-0.74)***	0.70 (0.57-0.86)***	307	21	0.67 (0.46-0.99) *	0.79 (0.51-1.21)
Number of cars								
1	2361	65	1.00		513	28	1.00	1.00
0	1129	50	0.53 (0.46-0.62)***	0.64 (0.53-0.78)**	359	14	0.43 (0.29-0.62)***	0.47 (0.30-0.75)***
2+	1801	74	1.49 (1.29-1.71)***	1.17 (0.97-1.40)	292	40	1.74 (1.27-2.39)***	1.46 (1.00-2.13)*
Smoking status								
Never	2444	79	1.00	1.00	-	-		
Ex	1683	73	0.72 (0.62-0.84)***	0.81 (0.68-0.97)***	-	-		
Light	846	33	0.13 (0.11-0.16)***	0.18 (0.14-0.22)***	846	33	1.00	1.00
Heavy	318	15	0.04 (0.03-0.06)***	0.09 (0.06-0.13)***	318	15	0.34 (0.23-0.49)***	0.47 (0.31-0.72)***
Number of adults								
2	2842	69	1.00	1.00	509	31	1.00	1.00
1	1745	58	0.61 (0.54-0.69)***	1.04 (0.88-1.23)	475	16	0.42 (0.31-0.56)***	0.75 (0.51-1.10)
3+	704	66	0.85 (0.72-1.00)**	1.07 (0.85-1.35)	180	33	1.10 (0.78-1.54)	1.07 (0.69-1.67)
Age of youngest child (years)								
No child <16	3982	64	1.00	1.00	813	24	1.00	1.00
0-4	597	77	1.85 (1.50-2.29)***	2.33 (1.71-3.19)***	154	42	2.36 (1.62-3.43)***	2.96 (1.77-4.96)***
5-10	392	66	1.09 (0.87-1.35)	1.17 (0.87-1.58)	115	29	1.29 (0.81-2.06)	1.34 (0.77-2.33)
11-15	320	71	1.34 (1.04-1.71)**	1.42 (1.03-1.97)*	82	41	2.18 (1.35-3.52)***	1.54 (0.94-2.52)

	All respondents				Smokers only			
Predictors	N	Smoke-free(%)	Univariate OR	Multivariate OR	N	Smoke-free(%)	Univariate OR	Multivariate OR
Year								
2006	1833	61	1.00	1.00	444	27	1.00	1.00
2007	1785	67	1.26 (1.09-1.45)***	1.30 (1.09-1.56)***	393	29	1.14 (0.82-1.57)	1.19 (0.82-1.71)
2008*	1673	72	1.58 (1.36-1.83)***	1.58 (1.31-1.90)***	327	30	1.18 (0.83-1.66)	1.22 (0.81-1.83)
Knowledge SHS illnesses			1.29 (1.26-1.32)***	1.18 (1.14-1.21)***			1.16 (1.11-1.22)***	1.10 (1.04-1.16)***
Agreement with restrictions			2.75 (2.52-2.99)***	1.78 (1.61-1.97)***			1.87 (1.60-2.19)***	1.64 (1.35-1.97)***

*Data collected in Feb/Mar 2009, *p<.05, **p<.01, *** p<.001

Table 14 Logistic regression predicting smoking abstinence when in a room with a child

	Abstain when in a room with *a child*			
Predictors	*N*	Abstain (%)	Univariate OR	Multivariate OR
Gender				
Female	3618	68	1.00	1.00
Male	3071	67	0.97 (0.87-1.08)	0.93 (0.82-1.05)
Age group				
45-64	2099	65	1.00	1.00
16-24	671	70	1.23 (1.05-1.48)**	0.95 (0.76-1.19)
25-44	3049	67	1.08 (0.96-1.21)	0.97 (0.83-1.14)
65+	870	71	1.32 (1.10-1.59)**	1.38 (1.12-1.69)**
Social class				
Skilled manual & non-manual	3108	67	1.00	1.00
Managerial &Professional	1677	77	1.64 (1.42-1.90)***	1.52 (1.29-1.78)***
Part & unskilled	1904	60	0.74 (0.65-0.84)***	0.82 (0.72-0.95)**
Number of cars				
1	2962	68	1.00	1.00
0	2084	61	0.73 (0.65-0.83)***	0.79 (0.68-0.92)***
2+	1643	73	1.26 (1.10-1.45)***	1.17 (1.00-1.37)*
Smoking status				
Light	4754	74	1.00	1.00
Heavy	1935	51	0.37 (0.33-0.42)***	0.44 (0.38-0.50)***
Number of adults				
2	3137	67	1.00	1.00
1	2554	65	0.90 (0.81-1.00)	0.99 (0.86-1.13)
3+	998	69	1.08 (0.93-1.25)	1.04 (0.88-1.24)
Age of youngest child (years)				
No child <16	4437	70	1.00	1.00
0-4	991	68	0.90 (0.78-1.05)	0.89 (0.73-1.07)
5-10	764	57	0.57 (0.48-0.67)***	0.52 (0.43-0.64)***
11-15	497	60	0.66 (0.54-0.80)***	0.61 (0.49-0.77)***
Year				
2003-06	2231	69	1.00	1.00
1996-2002	3741	64	0.78 (0.69-0.88)	0.85 (0.74-0.97)
2007-08	717	78	1.55 (1.26 -1.91)	1.77 (1.40-2.24)
Knowledge of SHS illnesses			1.14(1.12-1.16)***	1.11(1.09-1.14)***
Agreement with restrictions			1.55(1.46-1.63)***	1.35(1.27-1.44)***

*p<.05, **p<.01, *** p<.001

Discussion continued…

such as smoke-free homes and smoking abstinence around others. Our findings show that respondents know SHS increases the risk of respiratory illnesses but are less aware of non-respiratory diseases. A quarter of the population were unaware that SHSe can cause heart disease in adults, whilst only a third knew SHS could cause ear infection in children and 55% cot death. Awareness has improved over the last decade, yet levels of knowledge remain low for these conditions.

'Good knowledge' (correct identification of an association between SHS and at least 8 of the 10 SHS-related illnesses) was most prevalent amongst never smokers (65%), falling to 34% among those smoking over 20 per day. In addition to being a non-smoker, having a child in the household, being aged 25-44 years, female and of higher social class were all predictive of good knowledge.

The multivariate analysis suggests that knowledge was highest during the period of frequent SHS-related mass media campaigns (2003-06) and that post-SFL there was no further increase in knowledge. This coincided with the end of SHS-related mass media campaigns which in 2007 ran from March to April only (Department of Health, 2007). To my knowledge there have been no further national, Government funded mass media campaigns that have focused specifically on SHS between May 2007 and March 2009 – the last data collection point of this study. Campaigns in late 2007 and 2008/9 focused on smoking cessation (Department of Health, 2007), and since April 2010 there have been no mass media campaigns at all (Aveyard et al., 2010).

Knowledge was associated with smoke-free homes and abstinence from smoking when in a room with others even once potential confounders had been adjusted for. The odds of smokers having a smoke-free home increased by 9% with each unit increase in knowledge. Similarly, with each additional increase in knowledge, the odds of smoking abstinence increased by 11% when with children. Although the findings are cross-sectional in nature, they do support earlier findings of a relationship between knowledge and a reduction in children's SHSe (Jones, et al., 2011; Kegler & Malcoe, 2002; Phillips, et al., 2007).

Knowledge did not increase in 2007-08 but smoking abstinence with children did, as did the prevalence of smoke-free homes amongst non-smokers. There was no increase in smoke-free homes amongst smokers in 2007-08 compared with 2003-06. Whilst it is unknown why abstinence increased with children when knowledge concurrently decreased, it may be the case that smoking parents are subject to social desirability bias which may lead them to either falsely report abstinence or truly abstain when in a room with a child but not go as far as to implement an entirely smoke-free home. What is clear from this study is that more smokers with good knowledge have a smoke-free home compared with those with poor knowledge, 35% versus 16% respectively (Table 12).

These findings are consistent with qualitative studies which suggest a relationship between knowledge of the dangers of SHS and SHS-protective behaviour (Gilpin, et al., 1999; Jones, et al., 2011; Ponsonby, et al., 1996). In California, smokers who believed that SHS was harmful were five times more likely to report living in a smoke-free home (Gilpin, et al., 1999) and in Tasmania, a mass media campaign highlighting the link between SHS and SIDS successfully reduced child SHSe (Ponsonby, et al., 1996).

Increasing knowledge of the impact of SHS is required to challenge cognitive dissonance-based rationalisation that smokers make to justify their smoking behaviour and to encourage them to change their behaviour rather than their beliefs (Borland et al., 2009; Jones, et al., 2011; Yong & Borland, 2008). Given that the results here show that good knowledge was not more likely in 2007-08 compared with 2003-06, there is a clear case for further education campaigns in order to increase population knowledge of the real dangers of SHSe. This knowledge should be framed in such a way that it combats functional and risk-minimising beliefs and provides practical advice on how to protect children from SHS. Research investigating the impact of mass media campaigns on SHS-related knowledge and subsequent behaviour is also warranted.

Although it is acknowledged that knowledge alone is unlikely to be sufficient to bring about behaviour change, given that knowledge acquisition is an important step in the process of behaviour change, especially with regards to population level changes involving changes in group social norm and that without knowledge, changes in attitudes and subsequent behaviour change is improbable(Borland, et al., 2009; Klesges, et al., 1988; Siahpush, et al., 2006; Stead, et al., 2001) , the low levels of knowledge revealed in this study are a cause for concern. This concern is further heightened by my findings of the significant relationship between knowledge and protective behaviours and that 50% of children are still exposed to parental SHS in the home.

This study quantifies levels of knowledge by population subgroups and provides quantitative evidence that the knowledge of SHS-related illnesses is predictive of keeping a smoke-free home and abstaining from smoking in the presence of children. This link between knowledge and behaviour and its concurrence with topical mass media campaigns has potential implications for policy and practice. Given the lack of evidence for what really works in terms of producing smoke-free homes (RCP, 2010; Roseby, et al., 2002) and that little had hitherto been known about the levels of national SHS knowledge in England, these

findings suggest a role for including knowledge in the development of future interventions and supports the recent call for further mass media campaigns to highlight the dangers of SHS (Jones, et al., 2011; RCP, 2010), in combination with information on the ineffectuality of some protective behaviours (e.g. using a combination of techniques has little protective impact on children's' cotinine levels) and how smoke-free homes can be achieved. The implications of this research will be considered in the context of the other findings of this thesis in the discussion.

5.4.1 Limitations

These data are cross-sectional; it would be useful to examine the relationship between knowledge and SHS-protective behaviours using longitudinal data but such data were not available. The logistic regression model of 'good' knowledge could have been a better fit, suggesting that there may be other important predictors of knowledge that we have not included in our analyses.

Due to the nature of self-reported data, we cannot rule out the possibility of social desirability bias amongst parents which leads them to report better knowledge (this notion is supported by the findings of Steil and colleagues (2010) who found that open ended questions elicited far fewer SHS-related illnesses than closed ended questions). Furthermore, it is not impossible that smokers wishing to seem considerate and mindful of others falsely report a smoke-free home or smoking abstinence when in a room with a child. These biases may have increased over time with the increased stigmatisation of smoking. However, cotinine measures have been used to verify self-reported prevalence of smoke-free homes in previous studies (Jarvis, et al., 2009; Jarvis, et al., 2011). Furthermore, some smokers may have a different view of 'smoke-free' than others as was found to be the case in a qualitative study with mothers, whereby some described their homes as non-smoking whilst also reporting that they smoke in an open doorway, believing that this still constitutes a non-smoking home (Robinson & Kirkcaldy, 2007a).

CHAPTER 6. A BRIEF MASS MEDIA INTERVENTION IN THE NORTH WEST AND NORTH EAST OF ENGLAND

6.1 Introduction

Fresh North East, England's first dedicated regional office for tobacco control, was set up in 2005 (Fresh, 2011). Fresh is responsible for developing a regional approach to reduce smoking and support the work of the Association of North East Councils, all 12 Primary Care Trusts, the Strategic Health Authority and local authorities in the region. Tobacco Free Futures in the North West of England performs the same function in the North West of England in conjunction with 24 NHS Primary Care Trusts in the region and with a goal of a tobacco-free future for everyone in the North West (Tobacco Free Futures, n.d).[12] In August 2010, Tobacco Free Futures launched a mass media campaign 'Take 7 Steps Out' which aimed to reduce children's exposure to tobacco smoke in the home. In this chapter, the campaign is evaluated using national survey data and the limitations of the campaign and the evaluation are candidly discussed.

[12] In England there is one other regional office for tobacco control, Smoke Free South West (Smokefree South West, 2010).

6.2 Background

In September 2010, after the 'Take 7 steps out' campaign had launched in August, the tobacco control research group at the University of Bath was approached by Tobacco Free Futures to evaluate the impact of the campaign on the home smoking behaviour of parents in the region using routinely available survey data. The YouGov survey (YouGov, 2012) was the only survey able to provide contemporary data for the evaluation (i.e. data for 2010 and a year later in 2011 by April 2011, when the analysis needed to be conducted). Following an initial scoping exercise in October 2010, it was noted that there were significant sample size limitations and that an evaluation using this data would be underpowered to detect small changes in behaviour (Evans, 2010). Nevertheless, Tobacco Free Futures decided they would like to proceed with the evaluation.

6.2.1 Smoking prevalence & SHSe in the North West and North East

Official smoking prevalence data for England are recorded by the General Household Survey (now the General Lifestyle Survey). The most recent publically available data is for 2009 (S. Robinson & Harris, 2011). National smoking prevalence in England was 21% in 2009. In the North East and North West prevalence was slightly higher than the English average at 22% and 23%, respectively.

Tobacco Free Futures commissioned the McCann Manchester marketing and communications group[13] to conduct some baseline measurements and conduct an evaluation of the 'Take 7 Steps Out' campaign. McCann estimated that in the North West (based on national figures presented in the RCP (2010) report and assuming the same level of exposure to SHS across England), approximately 33,000 GP appointments and over 1,000 hospital admissions of children each year are attributable to SHSe. This equates to a direct annual cost of £2.68 million to the NHS in the North West alone. The North East estimated that SHSe leads to approximately 12,600 GP appointments every year and 400 hospital admissions (McCann, 2010). They report that given that smoking prevalence is higher in the NW/NE these estimates are likely to be conservative.

[13] http://www.mccannmanchester.com

6.2.2 'Take 7 Steps out' campaign

The 'Take 7 steps out' mass media campaign was designed with the help of McCann Manchester, a marketing communications company, to reduce the health impact of SHS on children and young people in the North West and North East (NW/NE) of England by promoting outdoor smoking amongst parents. The campaign was conceptualised and developed in the North West and then extended to include the North East. The Core message of the campaign was that making homes completely smoke-free, by taking smoking outside of the home, is the only effective means of protecting children from SHS. Other measures such as opening a window or limiting smoking to certain areas within the home do not provide sufficient protection from SHS. The tag line of the campaign was: "**To help protect children from SHS, take 7 steps out; because most of the harmful chemicals in cigarette smoke are invisible."**

The campaign was designed to be emotionally charged to tap into parents' innate inclination to protect their children from harm. However, it was very clear in the guidelines produced by McCann, that the use of shock tactics that invoke fear should be avoided. This is in contrast to the findings of a number of recent studies (Davis, et al., 2010; Dunlop, et al., 2008; NCI, 2008; WHO, 2011). Parents should be informed that their current 'protective' behaviours (such as opening windows or smoking in a separate room) do not work and that the most effective way to protect their children would be to take 7 steps out.

The TV ad starts with a young girl drawing 7 hopscotch boxes on the floor in the back yard. A female parent comes to the back door and completes the 7 steps of the hopscotch whilst the narrator tells us "*most of the harmful chemicals in cigarette smoke are invisible, even if you open a window, stand at the back door, or move to another room. It isn't enough to keep your children safe. Help protect them from cigarette smoke, take 7 steps out*." As the narrator concludes the woman is shown smoking a cigarette at the end of the 7 steps of the hopscotch and the little girl is shown hopping back inside the house.

6.2.3 Target audience research

Tobacco Free Futures identified their primary target audience as parents and carers of children and infants under the age of 11. Before producing their campaign Tobacco Free Futures commissioned the McCann group to conduct some target audience research to develop appropriate and targeted campaign messaging. A survey of 500 respondents in the North West led to the segmentation of the target audience of smokers into 4 groups:

1. 'Mutables' who plan to give up smoking
2. 'Mutables' who plan to continue smoking
3. 'Indifferents'
4. 'Intractables'

Mutables were defined by the McCann group as those whose 'guilt button' is near the surface. Mutables admit that SHSe has health consequences and are willing to make an effort to limit the risk to others. Indifferents were defined as smokers who would admit there is a potential harm of smoking to others if heavily prompted but who are more likely to be concerned about children copying their behaviour than the health impacts per se. Finally, McCann defined intractables as those who refuse to acknowledge that their behaviour could be construed as harmful or wrong. The mutable group made up just over half of smokers in the North West (52%) and were identified as the most amenable to change and were therefore the primary target of the 'Take 7 Steps Out' campaign. To maximise the impact, the McCann group suggested that mutables would be most responsive to a campaign that promoted behaviour change rather than health information on the dangers of SHSe because mutables already understood these.

Information about the campaign design, content, background research was gathered from a document developed by the McCann group in May 2010 to inform the development of the campaign. However, the broader literature is not referred to at any point in this document and therefore the claims that mutables would be most responsive to behaviour change messages in the media and, that there was no requirement for a knowledge component, are unsubstantiated.

6.2.4 Pre-campaign evaluation of draft materials

After identifying the target audience McCann reported that discussions regarding the campaign (they did not specify with whom), lead to the conclusions that the campaign slogan 'Take 7 Steps Out' was a memorable call to action, which delivered a clear message to go right outside the home to smoke and made it unambiguous that standing on the door step or at the window is not far enough away from the home. McCann reported that the memorable branding encourages smokers to smoke outdoors by tapping into parents' innate desire to protect their children and facilitating a change in their behaviour by role modelling the protective response of smoking in the garden away from the house. Despite discussing the brand identity of the campaign with others, the actual advert was not piloted with the target audience.

6.2.5 Campaign specifics

6.2.5.1. TV ads

The campaign was aired on TV in the NW/NE between August and September 2010 and again between the 1st and the 19th December 2010.

Wave One

- *10th August 2010 – 12th September 2010: Ad on regional ITV (Tyne Tees)*

The ad was shown in the ad breaks for the following shows, X-Factor, Emmerdale, Coronation Street, Magic numbers, ITV News. Who wants to be a millionaire, Jeremy Kyle, Loose Women, This Morning and 3@3. On the daily shows McCann aimed to get the ad shown approximately twice per week. On a daily basis the ad was shown between 3 and 5 times.

- *10th August 2010 – 12th September 2010: Life channel (58 GP practices)*

- *10th August – ~ 3 months later: Baby TV (aired in 3 hospitals: Newcastle, Sunderland & Middlesbrough)*

Wave Two

- 1st December 2010– 19th December 2010: Ad on regional ITV *(Tyne Tees)*

6.2.5.2. *Print media*

In addition to the TV ads, 25,000 leaflets were also sent out to GP surgeries and children's centres in each Primary Care Trust in the region plus an extra 6,000 to PCT resource centres.

6.2.5.3. *Advice for health practitioners*

Guidance was given to health and social care practitioners throughout the region on how best to engage with smokers in order to initiate and facilitate the introduction of a smoke-free home.

6.2.5.4. *Public relations work*

Messages delivered by the campaign were reinforced with support packs available at road shows, through website support and health and social care professionals and through earned media via local newspaper and radio coverage. An interactive public relations road show toured 24 locations across the North West (one day each) in August and September, delivering the 'Take 7 steps out' message. Steparoo the kangaroo was the 'Take 7 steps out' mascot who was present at every road show. The mascot was used to attract attention and engage with younger children with the goal of encouraging parents to approach the road show.

6.2.6 Evaluation of the 'Take 7 Steps Out' campaign by 2CV

In addition to the benchmarking research in the NW/NE in April 2010, McCann also conducted a post-campaign survey in November 2010 of campaign recall, and any behavioural changes following the first wave of the campaign.

6.2.6.1. Recall

The post-campaign survey was conducted with a sample of 527 smokers with children in the North West and 429 in the North East. In the North West, a total of 43% spontaneously recalled seeing any recent tobacco related media. Of this 43%, 14% of recall was specifically related to the 'Take 7 steps out' campaign. When shown the TV ad, leaflet and public relations media coverage, recall of the 'Take 7 steps out' campaign increased from 14% to 39%. In the North East, a total of 49% spontaneously recalled seeing any recent tobacco related media, 28% of this recall was specifically related to the 'Take 7 steps out' campaign, again when shown the campaign materials, aided recall increased. In both regions, those identified as mutables, were most likely to recall the campaign.

In both the NW/NE, of all those who recalled the campaign (either aided or unaided), approximately three quarters felt that the TV ad provided them with at least some information that they had not previously known, two-thirds agreed that the TV ad made them realise how easy it was to take 7 steps out and just over half said that they wanted to go outside to smoke.

6.2.6.2. Behaviour change

In terms of behaviour change, 19% of respondents in the North West and 28% in the North East, who recalled the campaign, reported that they had gone outside to smoke after seeing the campaign. However, this information did not tell us whether these respondents used to smoke outside anyway or whether these respondents then smoked exclusively outside. In the long-term, to adequately assess any impact on children's level of SHS exposure, we need to know whether parents are making their homes completely smoke-free and whether this behaviour is maintained in the long-term.

6.2.7 Concluding comments from McCann Manchester

McCann concluded that, two months following the campaign, it was encouraging to see a behavioural impact. They stated that "*Smokers were encouraged by the advertising to take 7 steps out and as a result, the proportion of smokers now smoking away from the house and their children had significantly increased*".

These results should be treated with caution, especially the claim that there has been a significant increase in the proportion of smokers smoking away from the home: no

statistical significance tests are presented; baseline and post-survey samples sizes in both regions differ considerably and it is unclear whether parents are smoking exclusively outside. Also, despite reporting that aided recall was very good (39% in the North West and 57% in the North East), this level of recall is much lower than other campaigns (Kosir & Gutierrez, 2009) and therefore raises questions about the reach of the campaign. Using Canada as an example, a SHS campaign aimed at increasing smoke-free homes and cars was aired between January 2005 and March 2005 and had 83% aided recall. A subsequent TV ad (different content but same aim) was run between December 2006 and March 2007 and achieved 93% aided recall.

Due to the limitations of such evaluations, and the benefits associated with using routine survey data (better sampling methods, relatively low cost as the structures are already in place, larger sample sizes in general), Tobacco Free Futures were keen to conduct a more statistically valid evaluation that could be generalised to both the NW/NE. Details of the subsequent evaluation using the annual YouGov survey are presented here.

6.3 Methods

6.3.1 Evaluation using routine data

Using YouGov survey data an evaluation of the impact of the 'Take 7 Steps Out' campaign on parental home smoking behaviour, and knowledge of SHS-related illness, was conducted.

The campaign commenced in August 2010. YouGov survey data were collected a year apart in March 2010 and March 2011; these were the only months in the year when relevant smoking questions were asked. It would have been useful to assess trends in smoke-free homes in the NW/NE and the rest of England prior to 2010, however questions on smoke-free homes were not asked by YouGov prior to 2010.

According to YouGov, its surveys are conducted using an online interview administered to members of the YouGov Plc GB panel of 185,000+ individuals who have registered to take part in surveys. An email was sent to panellists selected at random from the base sample inviting them to take part in the smoking related survey. YouGov Plc normally achieves a response rate of between 35% and 50% to surveys however this does vary dependent upon

the subject matter, complexity and length of the questionnaire. The sample is normally matched to the demographic composition of the national census data. YouGov plc reports that they make every effort to provide representative information. All results are based on a sample and are therefore subject to statistical errors normally associated with sample-based information. Data are intended to be representative of England as a whole but YouGov data, which are stratified by region, are not matched to the Office of National statistics population estimates for each region. It should be noted that the YouGov survey provides less methodologically rigorous data than the OS or the HSE. Yet YouGov is designed to provide timely data on contemporary issues of significance and were the only routinely collected survey data available for the two periods of interest, pre-campaign in 2010 and post-campaign in 2011.

6.3.2 Power to detect a small effect size

Smoking related data from the YouGov survey were only collected in March 2010 and March 2011,thereby making it difficult to decipher from an analysis of this data whether any change between these time periods was attributable to the campaign or due to other factors that could influence smoke-free home prevalence and which have changed between these two time periods. The YouGov survey is conducted in all of England and we can therefore use the rest of England (excl NW/NW and SW) as a control group as there were no national tobacco control mass media campaigns running in England at this time.

The goal of the analysis was to assess whether a change between March 2010 and March 2011 in the NW/NE was significantly different from the rest of England under the null hypothesis that if there had been no campaign in NW/NE then the change observed would be akin to that in the rest of England.

For hypothetical percentage changes in the rest of England, the smallest percentage change that could be detectable in a statistical analysis with 80% power was calculated.

When the University of Bath were approached to conduct this evaluation in September 2010, the 2010 YouGov smoking data had already been collected and therefore the sample size was fixed. In 2010, the total sample for the NW/NE combined was 1,890, within this sample there were 277 smokers with children. This is a relatively small sample of smokers

to conduct an evaluation with. In 2011, it was possible that YouGov were in a position to be able to boost the sample of smokers with children by 2.4 times.

Power calculations were used to determine how much change could realistically be detected with 80% power if the sample of smokers with children in 2011 was boosted by 2.4 times or if it remained the same as the acquired sample in 2010 (Table 15).

In March 2010, the YouGov data showed that 48% of smokers with children reported that their home was smoke-free in the NW/NE; this is exactly the same proportion as the rest of England (Figure 12). Using the power calculator it was determined that if smoke-free homes amongst smokers with children in the home in England did not increase at all (i.e. remained at 48%), then assuming that YouGov achieved the same sample size as 2010, smoke-free home prevalence in the NW/NE in the homes of smokers with children would need to increase by at least 14% to be confident that this change is a result of the intervention (Table 15). If the proportion of smoke-free homes in the rest of England increased, then an even larger increase, than the one specified above, in the NW/NE would need to occur to be confident that it was a true representation of the home smoking behaviour in the NW/NE.

With the proposed YouGov boost of sample of smokers with children by approximately 2.4 times from 277 to 636, the percentage change to achieve 80% power was improved by just 1%. Although this is a poor improvement in detectable effect size, Tobacco Free Futures decided to commission the YouGov sample boost based on these calculations. They felt that recruiting more smokers into the sample would make the data for the stratified samples more compelling despite being advised that it was likely that the evaluation would be substantially underpowered (Evans, 2010).

In the following analyses data for the NW/NE combined are compared with the rest of England with the North East, North West and South West of England excluded. The South West is excluded as the regional tobacco control office here had been running their own media campaigns, including campaigns on SHS and could not therefore; act as an appropriate control group.

Table 15 Reliably detectable percentage changes in smoke free homes with 80% power

Smokers with children in the home			
	England	NW/NE (smallest % change detectable with 80% power)	
	% increase in smoke-free homes	Same sample as 2010	Boosted sample
	0%	14%	13%
	1%	15%	14%
	2%	16%	15%
	3%	17%	16%
	4%	18%	17%
	5%	19%	18%
Sample	896	277	636

6.3.3 Outcome measures

The following questions were asked in the March 2010 and March 2011 YouGov survey and are used here to assess any significant changes in knowledge and home smoking behaviour.

6.3.3.1. Knowledge

Smokers' opinions on the link between SHS and one adult-related illness and one child-related illness were assessed:

- *'How much of an impact do you think SHS has on increasing the risk of Heart attack?'*

- *'How much of an impact do you think SHS has on increasing the risk of Sudden Infant Death Syndrome (SIDS/cot death)?'*

Response options include: *big impact, some impact, little impact, no impact* and *don't know*. Those who responded big impact or some impact were pooled together to describe a group of smokers who were aware of a link between SHS and these illnesses.

6.3.3.2. Behaviour

To ascertain respondents' home smoking policy they were asked *'Which of the following best applies to your home? Smoking allowed everywhere, smoking allowed in some rooms, smoking allowed in non-enclosed areas, smoking not allowed anywhere.'* For the purposes

of the analyses, smoke-free homes were defined as those where smoking was not allowed anywhere.

6.3.4 Analyses

Z-tests for proportions were used to see whether changes in knowledge from 2010 to 2011 between the NW/NE differed significantly from the rest of England.

Logistic regression analyses were then conducted to determine whether the proportion of smoke-free homes changed over time whilst controlling for other potentially confounding factors, and whether the proportion of smoke-free homes differed between the NW/NE and the rest of England. Three regression analyses were conducted: one for all respondents, one for all smokers and one for only those smokers with children in the home (the target audience).The predictor variables included in all analyses were: year, region, age group, gender, smoking status, social grade[14] and having a child less than 18 years. An interaction term was included to test whether the change in proportion of smoke-free homes from 2010 to 2011 differed between regions. Prior to the main analysis, Pearson univariate correlations were conducted between predictor variables to screen for multicollinearity. No such relationships were found and so all of the aforementioned variables were included in the models. Following univariate logistic regression analyses where the relationship between each predictor variable and the outcome is explored independently, a multivariate logistic regression analysis was conducted using a forced entry method to identify the variables independently and significantly (p<.05) associated with each outcome whilst adjusting for the influence of other variables in the model. As in chapter 5, the predictive ability of each of the models was assessed using the area under a Receiver Operating Characteristic curve (AUC). A value of 1 represents perfect predictive fit whereas 0.5 means the model is synonymous with a random guess. A value greater than 0.7 generally indicates a model has good predictive ability (Field, 2005).

[14] Social Grade: A – High managerial, administrative or professional; B – Intermediate managerial, administrative or professional, C1 – Supervisory, clerical and junior managerial, administrative or professional; C2 – Skilled manual workers; D – Semi and unskilled manual workers; E – State pensioners, casual or lowest grade workers, unemployed (British National Readership Survey, n.d)

6.4 Results

6.4.1 Sample Characteristics

At baseline in 2010 the YouGov survey was completed by 1376 respondents in the North West, 514 in the North East, and 7337 respondents in the rest of England (Table 16). The 2011 post-campaign survey was completed by 1406 respondents in the North West, 525 in the North East, and 7487 respondents in the rest of England.

In the North West and the rest of England approximately 48% of respondents were male. In the North East this is slightly higher and increases further in 2011. Social grade differs between the three regions and changes between 2010 and 2011 in the NW/NE. This may reflect the fact that smokers were boosted in 2011 and therefore there was a slight increase in the proportion of respondents from lower social grades in these regions. This is also the case for smoking status; the increases do not reflect a sharp increase in smoking prevalence in 2011 in the NW/NE, it reflects the 2011 sample boost of smokers with children.

In 2010, approximately 15% of respondents in each region were smokers with children. Due to the boosted sample in the NW/NE in 2011, the proportion of smokers with children increased to 31% in the North East, 34% in the North West compared with 16% in the rest of England.

Table 16 YouGov sample demographic characteristics

	North East		North West		England†	
	2010	2011	2010	2011	2010	2011
Gender						
Male	50.7	53.1	48.0	47.7	48.5	48.2
Female	49.3	46.9	52.0	52.3	51.5	51.8
Social Grade						
Professional & Managerial	19.9	20.2	25.2	22.8	26.3	26.9
Clerical & administrative	24.6	26.5	28.1	27.7	30.0	29.9
Skilled Manual	22.4	21.9	21.7	21.3	20.1	20.6
Part skilled & Unskilled	24.0	20.8	16.8	18.7	15.7	14.9
Low grade or unemployed	9.2	10.5	8.3	9.6	7.9	7.7
Age group						

	North East		North West		England†	
	2010	2011	2010	2011	2010	2011
18-24	10.5	11.3	8.9	10.4	13.0	12.9
25-34	18.3	17.2	17.9	19.2	18.7	17.3
35-44	15.8	20.0	17.4	20.9	16.7	16.4
45-54	22.6	18.7	19.0	17.0	17.3	18.4
55+	32.7	32.8	36.8	32.5	34.2	35.0
Smoking status						
Never smoker	46.5	37.0	43.1	35.6	46.4	48.6
Ex	34.2	27.2	35.2	24.9	33.6	32.7
Non-daily	5.1	6.7	4.5	6.7	4.8	4.7
Daily	14.2	29.1	17.2	32.9	15.3	14.0
Children						
Have children	69.8	71.4	66.4	71.3	61.2	60.3
Do not have children	30.2	28.6	33.6	28.7	38.8	39.7
Sample	514	525	1376	1406	7337	7487

†Excluding the South West of England

6.4.2 Knowledge of the illnesses caused by SHS

6.4.2.1. Heart Attack

In 2010, in comparison to England, a lower proportion of smokers with children in the NW/NE believed that SHS has a big or some impact on the risk of heart attack (53.8%, (95 CI 47.9-59.7%) in the NW/NE compared to 57.5% (95% CI 54.3-60.8%) in the rest of England; (Table 17). In 2011, there was an increase in the NW/NE to 59.7% (95% CI 55.9-63.5%) of smokers with children believing that SHS had a big or some impact on the risk of heart attack, whilst in England there was a decline from 57.5% (95% CI 54.3-60.8%) to 51.2% (95% CI 47.8-54.6%). A z-test for proportions found that the change in knowledge between 2010 and 2011 was significantly different between the NW/NE and the rest of England (p <.001).

6.4.2.1. Sudden Infant Death Syndrome

In 2010, in both regions, approximately 41% of smokers with children believed there is either a big impact or at least some impact of SHS on SIDS (Table 17). There was a significant difference in the change in knowledge over time between the NW/NE and the rest of England (p <.05). In the NW/NE this belief increased from 41.2% (95% CI 35.4-47.0%) to 49.6% (95% CI 45.7-53.5%), whilst in England there was a slight decrease from 40.7%

(95% CI 37.5-44.0%) to 39.7% (95% CI 36.4-43.1%). In 2010, in the NW/NE and the rest of England, approximately 31% of smokers with children reported that they did not know whether SHS has an impact on SIDS or not, this uncertainty decreased by approximately 3-4% in 2011 in both regions.

Table 17 What impact does SHS have on heart attack and SIDS?

	Proportion of smoker with children <18 years at home (95% CI)	
SHS impact on Heart Attacks	North West & North East	England†
2010		
Big/some impact	53.8 (47.9-59.7)	57.5 (54.3-60.8)
Little impact	26.7 (21.4-31.8)	22.0 (19.3-24.7)
No impact	6.1 (3.3-8.9)	8.0 (6.3-9.8)
Don't know	13.4 (9.3-17.3)	12.5 (10.3-14.7)
Sample	277	897
2011		
Big/some impact	59.7 (55.9-63.5)	51.2 (47.8-54.6)
Little impact	22.7 (19.4-25.9)	28.9 (25.8-32.0)
No impact	6.8 (4.8-8.7)	8.5 (6.6-10.4)
Don't know	10.9 (8.4-13.3)	11.5 (9.3-13.6)
Sample	635	838
SHS impact on SIDs		
2010		
Big/some impact	41.2 (35.4-47.0)	40.7 (37.5-44.0)
Little impact	15.1 (10.9-19.3)	16.4 (14.0-18.8)
No impact	12.6 (8.7-16.5)	12.3 (10.1-14.4)
Don't know	31.3 (25.8-36.7)	30.6 (27.6-33.6)
Sample	277	896
2011		
Big/some impact	49.6 (45.7-53.5)	39.7 (36.4-43.1)
Little impact	14.0 (11.3-16.7)	20.9 (18.1-23.6)
No impact	8.7 (6.5-10.8)	13.3 (11.0-15.6)
Don't know	27.7 (23.3-30.2)	26.1 (23.2-29.1)
Sample	635	838

†Excluding the South West of England

6.4.3 Behaviour: Home smoking policy

In 2010, 48% of smokers with children in the household reported a smoke-free home in both the NW/NE and the rest of England (Figure 12). In 2011, the NW/NE saw a 4% increase in the proportion of smoke-free homes from 47.8% (95% CI 42.0-53.7%) to 52.3% (95% CI 48.3-56.1%). However, in the same period, the rest of England also saw an increase of 2% from 48.2% (95% CI 44.9-51.4%) to 50.4% (95% CI 47.0-53.8%).

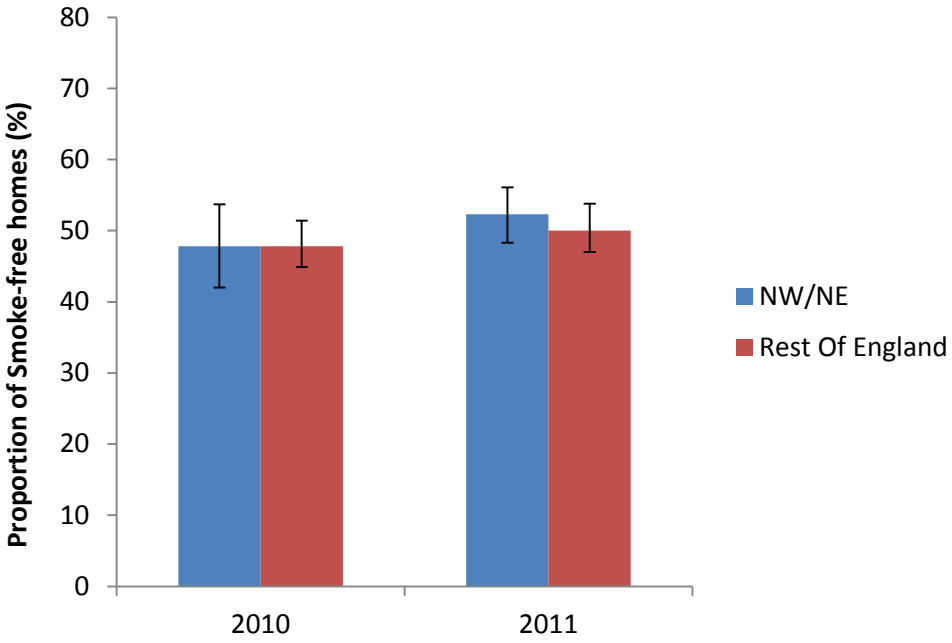


Figure 12 Proportion of smoke-free homes in the NW/NE compared to the rest of England pre- and post-campaign

6.4.4 Predicting a smoke-free home

6.4.4.1. All respondents

The multivariate adjusted analysis results found that the odds of having a smoke-free home increased significantly from 2010 to 2011 (OR 1.22, 95% CI 1.04-1.44). Using data from 2010 and 2011 combined, the NW/NE had lower odds of a smoke-free home compared to the rest of England (Table 18). Unsurprisingly, smokers were much less likely than non-smokers to have a smoke-free home (OR 0.12, 95% CI 0.11-0.13), whilst those with children in the home were much more likely to (OR 1.66, 95% CI 1.51-1.82). Younger respondents were more likely to have a smoke-free home (OR 2.40, 95% CI 2.14-2.69 for 18-34 year olds and OR 1.54, 95% CI 1.40-1.69 for 35-54 year olds) compared to over 55s. Those of lower social grade were less likely to have smoke-free homes compared to those in social grade

category A or B. There was no significant interaction between year and region indicating that there was no evidence that change in the proportion with smoke-free homes from 2010 to 2011 differed significantly between the two regions, confirming a non-significant effect of the NW/NE intervention. Overall the model correctly classified 82.5% of respondents. The model chi-square was significant, suggesting that the model for smoke-free homes with all the predictors in it was much better than a model with just the constant included, $\chi^2(10) = 3001.18$, $p < .001$ and the ROC curve analysis revealed that the model had good predictive ability, AUC = .75.

Table 18 Logistic regression analysis predicting smoke-free homes (all respondents)

Predictor	*N* (18,450)	Univariate	Multivariate
Gender			
Male	8,913	1.00	1.00
Female	9,537	0.96 (0.90-1.03)	0.99 (0.91-1.07)
Year			
2010	9,202	1.00	1.00
2011	9,248	1.03*** (0.96-1.10)	1.12* (1.02-1.33)
Region			
England†	14,199	1.00	1.00
North West & North East	4,251	0.70*** (0.65-0.77)	0.84** (0.72-0.99)
Smoking status			
Non-smoker	14,856	1.00	1.00
Smoker	3,594	0.13*** (0.12-0.14)	0.12*** (0.11-0.13)
Children <18			
No	6,584	1.00	1.00
Yes	11,866	1.05 (0.98-1.13)	1.66*** (1.51-1.82)
Social Grade			
Professional & Managerial	7,083	1.00	1.00
Skilled Manual and Non-manual	8,258	0.67*** (0.61-0.73)	0.71*** (0.64-0.78)
Part & Unskilled & Unemployed	3,109	0.43*** (0.39-0.47)	0.52*** (0.47-0.59)
Age			
55+	7,423	1.00	1.00
18-34	4,624	1.53*** (1.39-1.67)	2.40*** (2.14-2.69)
35-54	6,403	1.13** (1.04-1.22)	1.54*** (1.40-1.69)
North West/North East*2011		-	1.09 (0.90-1.32)

† Excluding the NW/NE and South West.*p<.05, ** p<.01, *** p<.001. Note: R^2 = .23 (Nagelkerke). $\chi^2(10) = 3001.18$, $p < .001$

6.4.4.2. All smokers

When restricting the analyses to smokers only, smoke-free homes were no longer associated with year or region of residence (Table 19). Males, those of higher social grade, and younger age group were all more likely to report smoke-free homes, as were those with children in the household (OR 2.12, 95% CI 1.81-2.50). The model correctly categorised 61.9% of respondents and is a significantly better model than one with just the constant included, $\chi^2(8) = 3.47$, $p < .001$. The AUC value was AUC = 0.68, suggesting that the model had moderate predictive ability.

Table 19 Logistic regression analysis predicting smoke-free homes (all smokers)

Predictor	*N* (3,594)	Univariate	Multivariate
Gender			
Male	1,877	1.00	1.00
Female	1,717	0.73***(0.65-0.82)	0.74*** (0.65-0.84)
Year			
2010	1,665	1.00	1.00
2011	1,929	1.08 (0.96-1.21)	1.11 (0.97-1.27)
Region			
England†	2,472	1.00	1.00
North West & North East	1,122	1.00 (0.88-1.15)	0.90 (0.77-1.04)
Children <18			
No	1,193	1.00	1.00
Yes	2,401	1.06 (0.94-1.20)	2.12*** (1.81-2.50)
Social Grade			
Professional & Managerial	1,054	1.00	1.00
Skilled Manual and Non-manual	1,700	0.75*** (0.64-0.88)	0.73*** (0.61-0.87)
Part & Unskilled & Unemployed	840	0.51*** (0.43-0.61)	0.49*** (0.40-0.59)
Age			
55+	1,170	1.00	1.00
18-34	891	3.26*** (2.78-3.82)	4.81*** (3.95-5.85)
35-54	1,533	1.74*** (1.50-2.01)	1.87*** (1.60-2.20)

† Excluding the NW/NE and South West. *p<.05, ** p<.01, *** p<.001. Note: R^2 = .11 (Nagelkerke). $\chi^2(8) = 3.47$, $p < .001$

6.4.4.3. Smokers with children

When just smokers with children less than 18 years of age were selected smoke-free homes were no more likely in 2011 than in 2010 or in the NW/NE compared to the rest of England

(Table 20). As in the above regression analysis, higher social grade and younger age were associated with increased odds of a smoke-free home, and females were less likely to have a smoke-free home compared to males (OR 0.68, 95% CI 0.58-0.80). The model correctly identifies 61.3% of the data and is a better model than a model with just the constant included, $\chi^2(7) = 192.58$, $p < .001$. The AUC value was AUC = 0.65, which once again suggests that the model for smokers with children had moderate predictive ability.

Table 20 Logistic regression analysis predicting smoke-free homes (smokers with children only)

Predictor	*N* (2,401)	Univariate	Multivariate
Gender			
Male	1,287	1.00	1.00
Female	1,114	0.66*** (0.57-0.77)	0.68*** (0.58-0.80)
Year			
2010	1,074	1.00	1.00
2011	1,327	1.10 (0.95-1.28)	1.09 (0.93-1.28)
Region			
England†	1,511	1.00	1.00
North West & North East	890	1.07 (0.91-1.26)	0.96 (0.81-1.14)
Social Grade			
Professional & Managerial	671	1.00	1.00
Skilled Manual and Non-manual	1,101	0.84 (0.68-1.02)	0.89 (0.71-1.11)
Part & Unskilled & Unemployed	629	0.62*** (0.50-0.77)	0.65*** (0.52-0.83)
Age			
55+	972	1.00	1.00
18-34	310	4.16*** (3.29-5.26)	4.42*** (3.44-5.67)
35-54	1,119	1.86*** (1.58-2.18)	1.81*** (1.52-2.15)

† Excluding the NW/NE and South West. *$p<.05$, ** $p<.01$, *** $p<.001$ Note: $R^2 = .09$ (Nagelkerke). Model $\chi^2(7) = 192.58$, $p < .001$

6.5 Discussion

The findings from the underpowered evaluation of the 'Take 7 steps out' campaign using YouGov survey data suggest that little has changed as a result of the media intervention. There was a 4% increase in the proportion of respondents who reported outdoor smoking in the NW/NE from pre-to-post campaign, mirrored by a 2% increase in the rest of England. If the study sample were larger and of adequate power then a 4% increase would be extremely positive. However, in this case no firm conclusions can be made. When assessing the prevalence of smoke-free homes in smokers only, there was no difference in smoke-

free home prevalence between 2010 and 2011 and prevalence was similar in the NW/NE and the rest of England. The presence of children in the home was an important predictor of a smoke-free home amongst smokers. These findings are supported by those in chapters 3, 4 and 5 which suggest that smoking parents take more protective when sharing the home with children. Amongst the target audience of the 'Take 7 Steps Out' campaign, the proportion of smoke-free homes amongst smokers with children in the home increased by approximately 2-4% between 2010 and 2011. However, there was no significant difference between 2010 and 2011 or between regions.

Similarly, whilst awareness of the association between SHS and heart attack and SIDS increased in this group in the NW/NE, with concurrent marginal declines in England, this study is substantially underpowered. Nevertheless, it is known that knowledge is a necessary pre-requisite for behaviour change (Farquhar, et al., 1984; Janz & Becker, 1984a; Klesges, et al., 1988), and so the increase in knowledge of the impact of SHS on the risk of heart attack and SIDS in the regions where the 'Take 7 Steps Out' campaign took place is encouraging, especially as England saw concurrent decreases. This tentatively suggests some impact of the intervention in the NW/NE and may also suggest that the lack of SHS-related public health mass media interventions in England from early 2010 was taking its toll. This finding provides justification for the sustained use of mass media campaigns and for better, more highly powered evaluations.

Based on the information provided earlier in the thesis (section 2.4), it should not be a surprise that, in this type of evaluation, this campaign has no discernible impact of SHS-related behaviour. Following mass media campaigns aimed at changing complex behaviours like smoking, small effect sizes should be anticipated and therefore, very large sample sizes would be required to reliably detect these small changes. In population level interventions a small change describes changes in the behaviours of thousands of people, i.e. a 4% increase in the prevalence of smoke-free homes would equate to thousands. However, even if a larger sample size had been achieved in this case, the campaign had a number of flaws.

First, the campaign was run for a total length of approximately 7 weeks only. The television ad was screened on regional ITV only and two other arguably lower impact channels in GP practices and 3 hospitals . A lengthier campaign may have aided greater campaign

exposure, as would the inclusion of the television advertisement on a greater number of TV channels.

Second, the campaign content may not have been as influential as anticipated. The television ad was designed to appeal to parents by showing a mother and child, but the message may have been more stimulating had it been designed to elicit negative emotions based on that relationship (Davis, et al., 2010; Dunlop, et al., 2008; Kosir & Gutierrez, 2009; NCI, 2008; Witte & Allen, 2000). None of the negative impacts of SHSe are described either verbally or visually. Although this was a deliberate omission by the ad designers as their target group were mutables and 'knew' the risks associated with SHSe, campaigns in Canada, New Zealand and Australia which have been deemed successful in increasing the prevalence of smoke-free homes used images that show children being exposed to SHS and describe the ill-effects that may result (Kosir & Gutierrez, 2009). A large scale review of anti-tobacco mass media campaigns conducted by the National Cancer Institute concluded that advertising that provoke strong negative emotions are more likely to produce the desired behaviour change than advertising that does not (NCI, 2008). However, the use of fear appeals can also produce avoidance behaviours if the subjects feel helpless to make the desired change, therefore, it is important that ads that include fear appeals also portray the behaviour change in question and provide information on where to receive advice or assistance with making this change (Witte & Allen, 2000). In the 'Take 7 steps out' ad, the parent role-modelled the appropriate behaviour, showing that going outside was effective and easy, thereby addressing individual's perceptions of self-efficacy of being able to take their smoking outside but the ad did not provide negative emotion to increase individual's perception of risk. Based on this information it is recommended that future SHS contain an emotive element. The most effective way of incorporating elements which have be proven to be effective in changing individuals' behaviour in previous media campaigns would be to use a theory of behaviour change in the development of the campaign, such as a social cognition model (Noar, 2006; Noar & Zimmerman, 2005; Randolph & Viswanath, 2004). It is not known whether the 'Take 7 steps out' campaign was derived using behaviour change theory. Although this thesis suggests that a broader approach to tobacco control policy more generally is necessary, models detailing the individual determinants of behaviour are helpful and relevant when attempting to devise and implement interventions. I short consideration of the individual determinants of behaviour in addition to the broader interpersonal, environmental, community and organisational determinants are of use. Theory can help guide all stages from the conceptualisation of the campaign to its

evaluation at the end (Hornik & Yanovitzky, 2003). Also, the 'take 7 steps out' campaign does not address any social network, community or societal level factors that may restrict smokers' ability to make their homes smoke-free, it only deals with some of the individual determinants of SHS-related behaviour. Furthermore, it has been suggested that anti-smoking mass media campaigns work best when conducted as part of a larger comprehensive approach to tobacco control. In 2010, no new national tobacco control policy interventions were implemented.

In the early stages following a mass media campaign, many evaluations measure campaign recall or changes in knowledge as measures of initial success (Hornik, 2002). Campaign recall of the 'Take 7 steps out' campaign was reported as good by McCann, however, in comparison to SHS campaign evaluations reviewed by Kosir and Gutierrez (2009), the level of recall recorded by McCann, was in fact, not very good. This may be indicative of insufficient exposure of the target audience to the campaign message or that the campaign message was ineffective.

Therefore it can be argued that the 'Take 7 steps out' campaign has provided a starting point for further campaigns to continue with the denormalisation of smoking behaviour. Evidence from other countries such as Canada, New Zealand and Australia that have run SHS campaigns show that changes in behaviour have occurred very slowly over time in conjunction with frequent campaigns year after year that have aimed to get smokers and non-smokers to amend their behaviours, thereby creating a climate where exposing others to SHS is not acceptable (Kosir & Gutierrez, 2009). Tracking small changes over time is imperative in order to show the cumulative impact of successive campaigns and changing social norms. This highlights the continued need for surveys to map changes over time longitudinally rather than just one year before and one year after a particular intervention.

6.5.1 Limitations

The guidelines of the 'Take 7 steps out' campaign, produced by Tobacco Free Futures, outlined an aimed 11.2% increase in the prevalence of smoke-free homes as a result of 'Take 7 steps out'. This was an unrealistic goal given the discussion in the literature about the modest impacts of mass media campaigns on complex behaviour change such as smoking behaviour which is often deeply rooted in social norms. "*Campaigns may take longer because they address behaviours with a deeper social or cultural anchoring, and*

individuals will take repeated convincing before they are ready to change" (Hornik & Yanovitzky, 2003). The fact that Smoke Free Futures hoped to see such a change highlights the need for better dissemination of knowledge from the academic sphere to organisations implementing interventions on the 'front line' and in order to manage the often unrealistic expectations of impact from funding bodies.

The before-and-after analyses were significantly underpowered. The size of the sample of smokers with children in the household was too small. Even with foresight to boost the 2010 sample as well as the 2011 sample, YouGov would not have been able to produce a sample large enough to detect small differences between the two years and between the NW/NE and the rest of England.

Due to the nature of the YouGov survey which gathers information on current salient issues, the questions which respondents are asked change regularly. A question on smoke-free homes has only been included since 2010 and therefore it is not possible explore smoke-free home prevalence over time. As aforementioned, trends are useful to gauge whether a current change is bigger, smaller or in keeping with changes in previous years. In the current evaluation, it is unknown whether a 4% increase in smoke-free homes in the NW/NE from 2010 to 2011 is in keeping with increases in earlier years or whether it is bigger or smaller than previously. However, this study was strengthened by the fact that the rest of England was used as a control group and that factors that may have an influence on smoke-free home prevalence were controlled for in the logistic regression analyses.

More generally, although routinely collected survey data are extremely useful, researchers not involved in the conceptualisation of the survey questions have to work with what they have. In the You Gov survey, the 'knowledge' questions are not ideally worded to capture knowledge per se, rather they are worded to capture perception of risk. 'How much of an impact do you think SHS has on increasing the risk of Sudden Infant Death Syndrome?' Furthermore, subjective decisions must be made as to which responses to group together. In this case big impact and some impact were grouped together to suggest that respondents 'knew' that SHS caused SIDS, whilst little impact and no impact were grouped to suggest that they did not know. Therefore, it is clear that these distinctions are not necessarily distinct in every case.

6.6 Conclusion

The 'Take 7 steps out' campaign laid the foundations for further tobacco control mass media interventions to continue with the denormalisation of smoking in the NW/NE. In light of the literature on other SHS campaigns and the assumptions of the ecological approach, a large impact on the prevalence of smoke-free homes should not have been expected by Tobacco Free Futures. An evaluation design that expects change after a short time, and includes too few respondents does not have the statistical power to detect minimal changes (Hornik, 2002).

Nevertheless, a larger sample size may have been able to tell us more about the small observed changes in smoke-free homes in the NW/NE of England. Future mass media campaigns should be devised using the literature (albeit limited) on SHS campaigns and behaviour change theory and any new initiatives in England should be based on previous campaigns that have been effective in countries such as Australia and New Zealand which are more emotive (Kosir & Gutierrez, 2009). This would help save a considerable amount of the resources that would be better spent on longer, more frequent waves of advertising, using multiple outreach methods which are spaced out over a number of years, in order to have maximum reach and impact.

CHAPTER 7. CONCLUSIONS

This conclusion starts by revisiting the aims of the thesis to remind the reader of the principal thesis' goals. The discussion of the thesis findings is then split into sections which relate to the main themes of the research. First in section 7.2, the prevalence of full and partial home smoking restrictions are assessed, thereby addressing aims 1 and 2 of the thesis (p32). Following this, section 7.3 moves on to discuss the determinants of children's SHSe and what factors might be modified to achieve further increases in smoke-free home prevalence, thereby reducing children's exposure, addressing aims 3, 4 and 5. Section 7.4 explores the use of mass media to reduce children's SHSe along with its limitations and potential for success, addressing aims 6 and 7. Following these discussions, the broad policy implications are discussed along with the main limitations of the thesis and suggestions for future research.

7.1 Revisiting the aims of the thesis

In the first instance, this thesis aimed to explore children's SHSe by assessing the prevalence of smoke-free homes in England and expanding the previous literature by exploring the trends in, and extent of, any other protective smoking behaviour in the home in (Aims 1 and 2). Given that it was known that children with smoking parents remain highly exposed to SHS (IARC, 2009; Jarvis, et al., 2009; G. King, et al., 2005; Lund & Helgason, 2005; Martinez-Donate, et al., 2009; Shopland, et al., 2006; Sims, et al., 2010) it was necessary to determine to what extent smoking parents try to protect their children from tobacco smoke in the home, what impact this has (Aim 3), whether this behaviour has evolved over time and what the determining factors of children's exposure are. In order to maximise the use of scant resources in the current economic climate it was important to determine which modifiable factors are likely to have most impact and therefore make recommendations on how to target future interventions (Aim 4). The current Government framework for public health interventions emphasizes the importance of evidence-based policies. It was possible post-SFL to assess the association of individual child factors, factors common to the household and area level factors with children's level of SHSe.

With this in mind, and given the lack of specificity in previous studies of knowledge of the health-impacts of SHS, this thesis aimed to assess people's knowledge of SHS-related illnesses (Aim 5). Previously, the majority of studies assessed whether people knew SHS was

'harmful'. It may be the case that the association between knowledge and protective behaviour is stronger when smokers know the specific illnesses their smoking may cause in their children. Increases in knowledge and any subsequent increases in SHS-protective behaviours were explored in relation to the concurrent sustained presentation of SHS-related mass media campaigns in 2003-2006 (Aim 6).

In addition to nationally presented SHS-related mass media campaigns run prior to the SFL in England, three years after the implementation of the legislation in 2010, a regional-level mass media campaign promoting outdoor smoking behaviour amongst smoking parents was conducted. Using routinely available data, Tobacco Free Futures commissioned a before-and-after evaluation assessing the impact of this campaign on the prevalence of smoke-free homes amongst smoking parents (Aim 7).

Taken together, this thesis aimed to understand children's SHSe in the home and suggest ways in which children can be further protected from parental SHS using comprehensive and multi-faceted tobacco control measures.

7.2 Prevalence of smoke-free homes and other protective behaviours

According to the OS data, the general population prevalence of smoke-free homes increased significantly between 2006 (pre-legislation) and 2008 (post-legislation) from 61% to 66%. However, this increase in smoke-free homes was not mirrored by smokers. In England, in 2008, only 30% of smoking households had a complete smoking ban. Crucially however, and in line with findings from earlier studies in England and the rest of the UK (Health Promotion Agency for Northern Ireland, 2009; Holliday, et al., 2009; Jarvis, et al., 2009; Jarvis, et al., 2011), there was no decrease in the prevalence of smoke-free homes amongst smokers. Furthermore, the presence of children under the age of 16 in the home increased prevalence slightly to 39%. This is in line with previous research (IARC, 2009), which found that the presence of children in the home increased the likelihood of smoking restrictions (Borland, et al., 1999; Gilpin, White, Farkas, & Pierce, 1999; IARC, 2009; Okah, Choi, Okuyemi, & Ahluwalia, 2002; Okah et al., 2003; Pierce et al., 1998; Berg et al., 2006; Borland, et al., 2006; Martinez-Donate, et al., 2009; Merom & Rissel, 2001; Pizacani et al., 2003; Shopland, et al., 2006).

Upon first inspection, these findings, which show that 61% of smoking households with children are not smoke-free, appear discouraging and represent little progress in the public health battle to protect children from SHS in the home. However, in 2008, in homes with children, the majority of smokers who smoked in their homes reported that they did not smoke when in a room with a child (64.8%, 95% CI 51.0-76.5%). Respondents were asked about whether they smoked when in the same room as a child from 1997, however, they were only asked whether they had a smoke-free home from 2006. Therefore, prior to 2006, it was not possible to explore the proportion of smokers who abstained when in a room with a child even though they did not live in a smoke-free home. Nevertheless, this analysis provided the first quantitative analysis of trends in 'protective' behaviours from 1997-2008 in England and showed that there was a large group of smokers who were doing more to avoid exposing children to SHS. Interestingly, those smokers who lived with other adults but did not live in a smoke-free home were more likely than those living with children in similar circumstances to abstain (82% vs. 65% respectively in 2008). This is likely to be a product of the relative ease of abstinence for smokers who do not routinely have to share a space with children compared to those smokers who may have difficulties leaving children unattended in the home in order to smoke outdoors (Phillips, et al., 2007; J. Robinson & Kirkcaldy, 2007b). Furthermore, in instances where a smoker who does not live with children in the home is in the presence of children, it is reasonable to assume that in many cases the children will not be their own off-spring, and as such, it may be viewed as inconsiderate of a smoker to expose other people's children to SHS. This study formed the foundation of this thesis and is the first to show in quantifiable terms that an increasing proportion of smokers in England are taking measures to reduce the amount of SHS in the home.

However, even though it is useful to determine whether smokers smoke in a room when a child is present, in this instance, using the OS data it was not possible to quantify how much protection this self-reported behaviour offered children. In the case of parent smokers that smoked in the home, but did not smoke in the same room as a child, there is likely to be a great deal of differentiation between households. Some may smoke everywhere in the home but not in the room that their child occupies at any one time, whilst at the other end of the continuum, some may restrict their behaviour considerably more by smoking on the doorstep only or in one room only etc. So whilst it is promising, that an increasing proportion of adult smokers refrained from smoking when in the same room as a child, it is difficult to ascertain to what extent this was protective.

In Chapter 4, the HSE analysis collected both parental self-reported child exposures to SHS, and objective cotinine sample measures of child SHSe and therefore strengthened the OS analysis by providing biologically validated measures of SHSe. This analysis revealed that post-SFL in 2008 and 2009 combined, half of children living with at least one smoker in the home were not exposed to SHS indoors. The findings were in line with Jarvis and colleagues most recent findings, that in 2008, 48% of children with smoking parents lived in smoke-free homes in England (Jarvis, et al., 2011). At first glance, the HSE finding in chapter 4 that approximately 50% of children live in a smoke-free home, appear to be far more positive than the OS finding in chapter 3 that 30% of households with smokers were smoke-free. However, these figures cannot be directly compared as the units of measurement are different; the OS provides information at the household level and the HSE at the child level. There are more children in smoking households (HSE) than there are smoking households with children in (OS) and as such these figures could actually be viewed as complementary.

Nearly half of children with at least one smoking parent were exposed to parental tobacco smoke inside the home. However, when exploring exactly where parents smoked, over half of children who were exposed to SHS in the home (29%) were exposed in one room only, whilst the remainder (21%) were exposed in at least two rooms. Unfortunately, it was not possible to discern whether restricting smoking to a certain number of rooms was conducted in addition to other protective behaviours such as abstaining from smoking in the same room as a child. It is reasonable to assume that performing both of these behaviours would have an increased protective effect on children. Nevertheless, there was a marked difference in children's cotinine levels dependent upon where their parents reported smoking (Figure 9). Those children whose parents smoked in one room only had an average cotinine concentration of 1.13ng/ml (95% CI 1.05-1.22ng/ml) compared with 2.36 ng/ml (95% CI 2.08-2.68ng/ml) for those who smoked in two or more rooms. This is a decline in children's cotinine levels of 52% when parents smoked in 1 room only compared to 2 or more rooms. Thus, contrary to previous evidence (Blackburn, et al., 2003), these findings controversially suggest that smoking in one room only in the household does in fact offer children some level of protection from SHS. The Surgeon General concluded in 2006 that 'the scientific evidence indicates that there is no risk-free level of exposure to second-hand smoke'(USDHHS, 2006), this was based on the fact that studies looking at the relationship between cotinine levels and illness have not found a cotinine cut off below which the excess risk of illness is zero. Kallio et al found increased incidence of early risk factors (arterial intima-media thickness, endothelial dysfunction) for coronary heart disease

amongst both 11 and 13 year olds, even at very low levels of exposure as indicated by low cotinine concentrations (Kallio, et al., 2007; Kallio, et al., 2010). However, it was the case that incidence of these risk factors decreased as cotinine levels decreased, therefore, lower SHSe amongst young adolescents equated to lower risk of cardiovascular disease in later life. It remains unclear whether there were any increased risks associated with very small cotinine concentrations (0.10ng/ml-0.39ng/ml) and so further work is required to clarify the health impacts of very low exposures to SHS.

Given that the average cotinine concentration for those smoking in one room only was 1.13ng/ml, this behaviour does not provide complete protection from the negative effects of SHS. Whilst it is promising that these children are less exposed to SHS and therefore at lower risk of illness than those whose parents smoke in more than one room, it would still be more beneficial to eliminate SHSe in the home altogether. While it is arguably better to take some protective measures than none, publicising a protective effect of smoking in one room only is not without its challenges. In instances where parents are unable or unwilling to go outside the home, the results in chapter 4 show that it is clearly better that they smoke in one room only rather than in multiple locations in the home. To this end, after assessing smokers' home smoking practices and assessing their motivation and ability to change, health practitioners could distribute this advice, whilst being sure to make it clear that outdoor smoking would be better. Extreme caution should be taken when considering this information for national mass media campaigns; it is likely that the presentation of such information would cause confusion, leading to potentially undesirable effects. For example, those who have already made the decision to smoke outside may be encouraged to come back inside and those who might be very close to taking their smoking permanently outside may be deterred from doing so. Furthermore, for those living in smaller dwellings or open plan layouts, smoking in one room is less protective than smoking in the kitchen with the internal door closed and the external door open in a larger dwelling. The potential for confusion and the need for these findings to be further substantiated and given that there are still health risks associated with the level of exposure found in one room (Kallio, 2007; 2010), suggests that mass communicated information on these findings is likely to offer little benefit. This finding presented in the wrong context may also provide the tobacco industry and its supporters with an opportunity to misrepresent the evidence in order to campaign for the reversal of the SFL or for the instalment of smoking rooms in indoor public places. Nevertheless, there are occasions where the promotion of smoking in

one room only will be the only viable option and it is arguably the case that such opportunities to reduce the harm from SHSe should not be overlooked.

Furthermore, irrespective of the negative health impacts of SHS on child health, by smoking in the presence of children, parents role model active smoking. In a before-and-after study evaluating the impact of the SFL in Northern Ireland, children with a smoking parent were more likely to believe that smoking was more prevalent in adults at both time points, than the national estimates, and were less likely to object to adults smoking around them and more likely to report that they may take up smoking in the future (HPA, 2009). This suggests a normalisation of smoking behaviour due to repeated exposure and modelling of the behaviour by adults (Alesci, Forster, & Blaine, 2003; Hudson & Thomson, 2011). This is a concern for public health which is attempting to decrease both SHSe and smoking prevalence and has implications for health inequalities as smoking is most prevalent amongst the most deprived and therefore this cycle continues to occur more often here. Future health promotion campaigns that aim to protect children from SHS should also inform parents that their children are more likely to smoke if they smoke. This was captured in one of the SHS-ads aired in England in 2003 titled 'I like what you like'. This creative highlighted that children imitate parental smoking behaviour by showing a child imitating a smoking action with his crayons.

7.3 What modifiable factors should future SHS-related interventions address?

In order to create more effective interventions to reduce the SHSe in the home for those children most exposed to tobacco smoke, multilevel analysis was conducted to understand which socio-demographic variables were significantly associated with children's cotinine levels and whether the most important determinants were individual child level factors, factors common to the household that the child lived in or the geographical area in which the child lived.

The analysis revealed that *where children's parents smoked* was a particularly powerful predictor of children's cotinine concentrations even when adjusting for all other individual level, household level and area level predictors in the model, and accounted for almost the same amount of unexplained variance at the household level as all the other individual level, household level and area level variables in the model combined. Where smoking occurs in the home is modifiable and therefore, these results provide a rationale for further

interventions which aim to encourage parents outside to smoke. At the same time, the fact biologically validated data show that 50% of children with smoking parents are not exposed in the home and a minority of children with smoking parents are exposed to SHS in more than one room (21%) in the home provides some level of reassurance that children are becoming increasingly less exposed to SHS in the home.

Within any intervention aimed at increasing smoke-free homes it is important to provide a rationale for why smoke-free environments are important, the most important of which are the health impacts on others. Whilst knowledge change on its own, is not sufficient to bring about behaviour change, it is an essential component. In chapter 5, analysis of the OS showed that **better knowledge** was associated with the increased likelihood of having a smoke-free home and smoking abstinence when in a room with a child. There was a dose-response relationship between smoking status and knowledge, with smokers having significantly poorer knowledge than non-smokers. Additionally, there was a relationship between smoking status and smoke-free homes, with never smokers being much more likely to have a smoke-free home than heavy smokers. Given that fewer smokers report good knowledge and are less likely to have smoke-free homes and given that knowledge is a modifiable factor, there is a real case to promote the use of interventions aimed at smokers which include information on childhood SHS-related illnesses and potential fatalities (in the case of SIDS).

A knowledge construct is included in some form in the majority of social cognition models that focus on the individual determinants of behaviour. Social cognition models would be useful in planning interventions to increase knowledge, but it is necessary to consider the broader sphere of influence (i.e. the ecological model) when attempting to change knowledge. Information about the danger of SHSe can be provided at the population level though mass media campaigns and also at the organisational level by dissemination of risk messages by health care providers. The fact that the largest increases in good knowledge of SHS-related illnesses in England occurred alongside focused SHS-related mass media campaigns in England between 2003 and 2006 and that better knowledge was positively associated with increased likelihood of having a smoke-free home and abstaining from smoking when in a room with a child supports the continued use of SHS mass media campaigns (there has not been a SHS related campaign since 2008 and there have been no public health campaigns at all since the build-up to the General Election in 2010).

The health secretary for the Coalition Government Andrew Lansley speaking at the '50 years since smoking and health' event at the Royal College of Physicians on the 6th March 2012 stressed the important role that mass media campaigns can play in the continued challenge to protect children from SHS. National SHS-related mass media campaigns were reinstated in March 2012 highlighting the fact that 85% of tobacco smoke is invisible and so children are exposed to toxins that parents cannot see whilst they are smoking out of a door or window. Whilst this message combats smokers' misconceptions about the protective effects of wafting the smoke away or holding a cigarette near an open window, it does not publicise the damaging health effects of SHSe. Based on the evidence in chapter 5, this knowledge element ought to be included in future campaigns.

The 'Take 7 Step Out' campaign was designed to be supportive and provide role modelling, the absence of any imagery that could elicit negative emotion was deliberate but it is likely that this omission was detrimental to the impact of the campaign (Davis, et al., 2010; Dunlop, et al., 2008; NCI, 2008; WHO, 2011). Additionally, the inclusion of information on specific childhood illnesses that can be caused by SHSe may have been beneficial. Following the 'Take 7 Steps Out campaign' there was some evidence of increases in knowledge of heart attack and SIDS amongst smokers in the NW/NE even though no specific illnesses were mentioned in the television adverts. It may be the case that general messages which report that SHS is harmful to children sent the implicit message that SHS is harmful, thus when asked about specific illnesses smokers are more likely to indicate that SHS is a causal factor in these illnesses. The target audience research conducted by the McCann group on behalf of Tobacco Free Futures prior to the 'Take 7 Steps Out' campaign suggested that their target audience of 'mutable' smokers were already aware of the dangers of SHS and that what really needed addressing were the misconceptions surrounding the effective ways to protect children from SHSe.

In chapter 5 of this thesis, it was found that in England, only 55% of the population in general were aware that SHS can cause SIDS and fewer still, 33%, were aware of the link between SHS and child ear infection in 2008 (Evans, Gilmore, Judge, & Sims, 2012). Smokers' knowledge was poorer. Whilst the findings of the mass media evaluation of the 'Take 7 Steps Out' campaign are more positive, with 60% of **smokers** with children in the NW/NE believing that SHS has an impact on heart attack and 50% believing it has an impact on SIDS. However, there is still clear room for improvement.

7.3.1 Other factors associated with children's SHSe

In addition to the modifiable factors above, there are a number of other factors that are associated with children's SHSe that require discussion. Which parent(s) smoked was predictive of children's cotinine concentrations. Children with smoking mothers only, or both parents that smoked, were significantly more exposed to SHS than those with smoking fathers only. This is most likely to reflect the differing child care roles of mothers and fathers. Typically, mothers spend more time in the home with the children than fathers. Therefore, fathers comparably have fewer restrictions placed on their ability to smoke outside the home than mothers. When caring for young children a decision has to be made either to smoke outside and take the children or leave the children unattended, a decision which mothers find less agreeable than smoking in front of their children (Robinson & Kirkcaldy, 2007a). Furthermore, if fathers are the only smoker in the home, it has been suggested that pressure from their non-smoking partners can force them to smoke outside of the home (Blackburn et al., 2005). This highlights the need to target interventions at those parents who spend the most time in the home with their children. This may be an appropriate group to test a substitution intervention whereby smokers substitute cigarettes with cleaner forms of nicotine when in the home (i.e. conventional NRT products). The safety of other nicotine products such as the e-cigarette are not regulated like NRT products and have not, as of yet, been declared 'safe'.

In line with findings from previous studies focusing on SEP and child SHSe (Akhtar, et al., 2010; Bolte & Fromme, 2008; IARC, 2009; Mills, et al., 2011; Sims, et al., 2010), socioeconomic factors were significantly associated with children's cotinine exposure in the HSE analysis and with the prevalence of smoke-free homes and abstinence when in a room with a child in the OS analysis. The highest level of education in the household was predictive of SHSe, with those children whose parents had no qualifications being significantly more exposed than those with school level or higher education level qualifications. Likewise, smoke-free homes and SHS-protective behaviours were significantly more likely amongst smokers of managerial and professional occupation, in comparison to those of skilled non-manual or manual occupation (OS). However, between 1997 and 2008 there has been a convergence in the proportion of smokers remaining abstinent when in a room with children between the highest and lowest social class groups due to a greater rate of change over the years from those of part skilled and unskilled

occupation. So in terms of partial restrictions those of lower social class are behaving in a similar manner to those of higher social class. Dwelling type was an important predictor of children's SHSe even after adjusting for educational status. Children's SHSe was significantly higher when they lived in an apartment or a terraced house in comparison to a detached house. This suggests that there is something characteristic about living in an apartment or a terraced house that makes it more likely that parents will smoke inside. In apartments there may be a complete lack of outdoor space i.e. no garden and no balcony. However, if this were the explanation for higher children's cotinine levels associated with dwelling type, then we would not expect to observe the same pattern of increased exposure for those children living in terraced housing, as it is possible to go outside of a terraced house for a cigarette with relative ease. It may be the case that issues of personal safety and garden size are having an effect here (Robinson & Kirkcaldy, 2007a). If this is true, then dwelling type can indeed be considered a proxy measure of social class (explaining separate variance to educational status, the other proxy measure of social class included in the multilevel model in chapter 4)[15], as those living in terraced housing and high-rise apartments are also more likely to have limited outdoor space (i.e. no space or confined gardens) and live in deprived areas where personal safety is a concern attached to outdoor smoking. Whilst there is no quick fix to make the gardens of terraced houses bigger, make residents in any given neighbourhood feel safer or create outdoor space in apartment blocks, legislation could be used to address indoor smoking in multiunit dwellings. There have been arguments for multi-unit dwellings to become smoke-free by law because of the evidence that there is transference of SHS into other non-smoking units (Bohac, Hewett, Hammond, & Grimsrud, 2011; Kraev, Adamkiewicz, Hammond, & Spengler, 2009).

This importance of socio-economic factors is further supported by the fact that nearly all of the unexplained variance in child cotinine concentrations at the area level was accounted for by the household level variables. It is likely that the higher smoking prevalence in the North and in urban areas is indicative of higher incidence of deprivation in these localities (Amos, et al., 2011) and therefore, any area level differences are likely to be almost entirely explained by socioeconomic factors.

[15] There is an argument that different proxy measures of SEP should all be included in regression models as they are likely to explain at least some unique proportion of the variance despite being related to one another (Galobardes, Lynch, & Smith, 2007).

In general, whilst chapter 3 provides some evidence of increased partial SHS protective behaviour by smokers of lower social class, there is no evidence here of an increase in total restrictions amongst this group. Interventions that focus on addressing the barriers that smokers of lower social class face when thinking about making their homes completely smoke-free require addressing. The majority of individual counselling interventions conducted to date have focused on more deprived groups with small positive effects in some cases (Gehrman & Hovell, 2003; NICE, 2009; Priest, et al., 2008; Roseby, et al., 2002). There is a case for pairing such interventions with mass media campaigns that address some of the barriers to smoke-free homes experienced by this group. Again nicotine based harm reduction techniques may be appropriate here.

A reduction in health inequalities between the highest and lowest SEP groups is a current aim outlined in the most recent public health White Paper *Healthy Lives, Healthy People* (DH, 2011). The White paper refers to the independent review on health inequalities conducted by Michael Marmot in 2010 where tobacco control was cited as key in the reduction of health inequalities, as smoking accounts for around half of the difference in life expectancy, between the highest and lowest SEP groups (Marmot, 2010). However, *Healthy Lives, Healthy People* does not suggest how a reduction in health inequalities is to be achieved. There is no quick fix for socioeconomic disparities. It is likely that a multidisciplinary intervention strategy at multiple levels of influence which aims to improve education, living conditions and access to services for those of lower SEP over a sustained period along with societal changes in social norms with regard to appropriate smoking behaviour will eventually help reduce this discrepancy (Gray et al., 2011; Marmot, 2010).

Social norms refer to the rules (often unspoken and not dictated by the law) that a social group adhere to. Whilst it has not been possible to directly measure social norms per se in this thesis, it has been possible to measure home smoking rules. Over time between 1997 and 2008 the increases in partial restrictions as found in the OS analysis (supported by more recent findings in the HSE analysis) alongside concurrent increases in good knowledge of the illnesses caused by SHSe suggest that the perceived acceptability of smoking in the home has changed. This thesis, in a similar vein to earlier studies (Jarvis et al., 2009; Sims et al.,2010; Jarvis et al.,2011) suggest that social norms are changing over time. Furthermore, social norms may be changing amongst those of lower social class given that there has been a marked increase in partial protective measures amongst the most deprived. Although it is not possible to attribute direct causality of these changes over time, given that they

occurred during a time when many tobacco control policy interventions were undertaken suggests that these policies have been changing the social norm of acceptable smoking behaviour.

7.4 Modest impacts of mass media

From the analyses in chapters 3, 4 and 5 it is clear that complex behaviour change takes time and is influenced by a number of factors at different levels of influence. Nevertheless, there is evidence to suggest that changes in complex behaviours do occur in sync with well designed, well-distributed, sustained mass media campaigns which are well supplemented by earned media (NCI, 2008; Pierce, et al., 2002). The use of mass media campaigns is one important method of intervention which can help with the further denormalisation of smoking behaviour (Bala, et al., 2008). However, even those anti-smoking campaigns heralded as a success show only modest effects. For example, McVey & Stapleton (2000) estimated that the John Cleese campaign decreased smoking prevalence in the intervention areas by approximately 1.2% following 2 waves of sustained advertising (each wave lasted 3 months).

Nevertheless, given the wide reach that mass media is capable of, a campaign with a small to moderate effect size in a national setting is likely to influence far more people and have a greater impact on public health than individual or community level interventions with a large effect size as these only reach a small number of people at a time (Noar, 2006) and given that individual and community level interventions aimed at increasing the proportion of smoke-free homes have had a limited and inconsistent effect (Gehrman & Hovell, 2003; NICE, 2009; Priest, et al., 2008; Roseby, et al., 2002), it might be the case the SHS mass media campaigns could have a greater impact or in combination with other measures they could have a synergistic effect. However, to achieve even modest impacts, mass media campaigns need have sufficient reach and have a clear and engaging message (Noar, 2006).

Despite the reach of a media campaign being crucial to its success, the ‘Take 7 Steps Out’ campaign ran twice for a total of approximately 7 weeks only and was broadcast on only one national TV channel and two other less viewed channels, the baby channel and health TV aired in GP surgeries and 3 hospitals in the NW/NE. Despite finding some evidence of increases in the proportion of smoking parents who believed that SHS had at least some impact on adult heart attack and SIDs, the ‘Take 7 Steps Out’ mass media campaign in the

NW/NE had no tenable impact on the proportion of smoke-free homes amongst smoking parents.

Given that in the current media world, where we increasingly watch programmes on demand rather than at the scheduled time, we can avoid watching advertisements altogether, and therefore the internet, and social media in particular, may be a better and more cost-effective way to disseminate public health messages (Hovell, et al., 2011). Future research needs to explore this issue in order for future health promotion campaigns to achieve the exposure they need to succeed. There is evidence to suggest that brief mass media interventions like 'Take 7 Steps Out' can work in the longer term if they are highly visible and repeated in successive years (WHO, 2011).

In this instance in addition to reach, the campaign content could also be improved by including imagery that is likely to evoke negative emotion in the viewer (Davis, et al., 2010; Dunlop, et al., 2008; NCI, 2008; WHO, 2011). As aforementioned, the results of this thesis would argue that mass media campaigns focused on reducing SHSe in the home need both a risks component and an effective protective behaviours component.

7.5 Using the ecological framework to intervene

This thesis has suggested that in order to encourage smokers outside of the home to smoke, smokers' knowledge of the dangers from SHSe need to improve. In individualistic social cognition models knowledge has a crucial role to play and therefore, it is of value to consult such models when devising future mass media interventions in order to use effective techniques geared towards behaviour change. However, this is just one strand of the overall approach that should be taken.

In line with the ecological perspective, behaviour cannot be viewed as external to the social context in which people live; their interpersonal relationships, social norms of the communities in which they live and the broader policy environment and therefore mass media campaigns might be expected to have a greater impact on the behaviour of individuals if they addressed the broader contextual issues of behaviour change in addition to the individual determinants. I.e. mass media campaigns that address common barriers

within social networks and smokers' living spaces, in addition to increasing individuals' SHS-related knowledge, might be expected to have a greater impact.

The presence of mass media campaigns and the level of earned media and public dialogue associated with such campaigns could influence policymakers and organisations by bringing pertinent contemporary issues to their attention. Each campaign should have an experienced public relations team to gather as much publicity as possible in other forms of media in order to make policy makers take notice which in turn may promote renewed dialogue which may lead to further population level strategies, including measures implemented at the organisational level to help change smoking behaviour. This is an example of how the ecological approach can be used to good effect.

In the current financial climate characterised by high competition for funding and limited resources, regional offices for tobacco control Fresh, Tobacco Free Futures and Smoke-free South West need to heavily supplement any mass media campaigns they run with determined media advocacy techniques to influence local coverage of tobacco issues and to gain as much earned media as possible. Indeed, all of these offices show evidence of this behaviour with active Twitter and Facebook accounts which are used to disseminate anti-tobacco messages and rally support for new policy initiatives (e.g. plain packaging currently). In this case, the results of this thesis propose that resources should be pooled to change the social norm of smoking in the home by including a SHS knowledge component in future interventions to encourage smokers outside.

7.6 Key policy implications

Whilst there are no overnight solutions for driving down the proportion of children still exposed to tobacco smoke in the home, the continued denormalisation of smoking in society is key. The fact that the proportion of smokers with partial smoking restrictions in the home has increased considerably since 1997, throughout a period which has witnessed a number of tobacco control interventions and policies, suggests that policy changes have cumulatively contributed to the reduction in children's SHSe. Furthermore, the largest increases in partial restrictions were found amongst the most deprived, suggestsing that this group are making significant changes. The precise mechanisms of these changes are unclear, however, given that SHS-related knowledge has increased over time, it is likely that some smokers' perceptions about what constitutes acceptable home smoking behaviour

has changed. With previous trends in both knowledge and home restrictions in mind, it can be hypothesised that continued tobacco control policies are likely to contribute to further changes in attitudes regarding the acceptability of smoking inside the home. Additionally, a continued cohesive public health tobacco control policy strategy that helps to decrease adult smoking prevalence would also unintentionally contribute to a reduction in children's SHSe.

The current Coalition Government has set a target to reduce adult smoking prevalence to 18.5% or less by 2015. The 2011 White paper set out a tobacco control strategy in accordance with the 6 strands of tobacco control outlined by the World Bank (p23). The White paper emphasised a multi-faceted approach with national measures being complemented by locally driven initiatives relevant to that locality. The work of this thesis relates directly to the fifth strand, 'reducing exposure to second-hand smoke'. Yet as a reduction of smoking prevalence and a change in social norms would have an impact on SHSe, each strand is mentioned in brief here.

First, to stop the promotion of tobacco, the Coalition have followed through with the implementation of a policy enacted under the Labour Government and have removed all cigarette vending machines in England and Wales, and prohibited point of sale advertising in stores occupying over 3000 square feet from April 2012, with all other stores required to comply by 2015. Additionally, there is now a consultation underway on standardised packaging legislation. In addition to these activities, the Government intend to explore the tobacco industry's use of the internet to promote tobacco to young people and consult with the film and television industry on the portrayal of smoking on screen. Secondly, to make tobacco less affordable, increases in taxation on tobacco consistently above rate of inflation are set to occur. In addition, the feasibility of restricting the amount of cheap cigarettes individuals can bring in from abroad will be assessed, and a joint working protocol between local authorities and HMRC will be promoted to tackle smuggling. Thirdly, effective regulation of tobacco products is to be upheld. The Government aims to enforce current policies and conduct further work on other nicotine delivery systems (e.g. safety of e-cigs) to inform the most appropriate level of regulation of these products. Fourth, an ecological framework (multilevel approach, even though this term is not used in the White Paper) has been suggested to help smokers to quit. At the population level, mass media campaigns should be used to motivate smokers to quit and to direct them towards SSSs that tailor quit attempts to the individual. At the organisational level, health care providers

should be trained to provide cessation advice and use every opportunity to intervene, and in cases where smokers cannot or will not quit, health care providers should inform smokers of the importance of smoking outside the home. Fifth, and of relevance to the findings in this thesis, the Government recognises the need to reduce exposure to SHS. The White Paper promoted the use of mass media campaigns to raise awareness of the risks to children from SHSe. The research in this thesis substantiates the importance and relevance of this recommendation. The sixth strand feeds into the use of mass media campaigns as it focuses exclusively on utilising effective communications for tobacco control, which are incorporated within each of the other strands here. In addition to mass media campaigns, communication strategies such as knowledge transfer, whereby methods of communication are established between research organisations and those involved in public health policy, and media advocacy can help keep the tobacco control agenda in the public dialogue.

7.6.1 Going further than Healthy Lives, Healthy People

In addition to the recommendations above, there are other measures that could contribute to changing the social norms of appropriate smoking behaviour and provoke subsequent reductions in children's SHSe. One such measure is the publication of tobacco industry tactics to the general public. In this respect, the CTCP provides an excellent template of the changes that can be achieved using a comprehensive approach to tobacco control that includes exposing tobacco industry tactics. In the early 1990s, California aired a series of advertisements exposing the fact that the industry deliberately targeted their marketing towards children, knew the health effects of tobacco long before they admitted it and knew that cigarettes were addictive (Pierce, et al., 2002). However, threats of legal action by the industry made it difficult for the CTCP to continue with this form of anti-smoking advertising. During the period of CTCP advertising there were marked declines in cigarette consumption which became attenuated once the ads ceased (Ibrahim & Glantz, 2007; Pierce, et al., 2002). In England, publication industry tactics that have been used over the years to undermine public health efforts, recruit young smokers and to keep smokers hooked, despite knowing of the grave consequences to health may be likely have a significant impact on the population’s attitudes towards the tobacco industry and ultimately, smoking.

To further reduce the amount of SHS children are exposed to there have been calls to utilise further legislation by prohibiting smoking in cars carrying children under the age of

16. Such a law exists in certain parts of Canada, the US and most of Australia. As of yet there are no studies evaluating the impact of bans on smoking in cars on children's level of SHSe, however, it has been argued that measures taken to protect children receive a large level of public support and therefore legislation to protect children by prohibiting smoking in cars has received much less objection from the industry than other legislative measures in tobacco control (Freeman, Chapman, & Storey, 2008). Therefore, Becky Freeman and colleagues at the University of Sydney, Australia, argue that tobacco control organisations and governing bodies should take advantage of this lack of opposition and implement legislation to prohibit smoking in cars carrying children thereby reducing SHSe and further diluting the perception of smoking as a normal behaviour.

It may also be helpful to engage with the pharmaceutical industry in order to make Nicotine Replacement Therapies cheaper and more widely available. Even if smokers do not intend to quit, health care practitioners can advise their use when it is not possible to go outside to smoke (RCP, 2010), thereby protecting others from the harmful effects of SHS.

In summary, there is not much convincing evidence of what works in terms of interventions directly aimed at increasing the prevalence of smoke-free homes, although there is limited evidence to suggest a modest impact of individual counselling interventions when delivered in the household (Gehrman & Hovell, 2003; NICE, 2009; Priest, et al., 2008; Roseby, et al., 2002). To motivate smoking parents to smoke exclusively outside the home, the ecological approach would advocate that interventions on a number of levels of influence would be the most effective way to achieve the desired change. So in combination with individual level interventions such as home counselling sessions or personalised air quality feedback, at the organisational level (as is the case with cessation advice) health care providers should reiterate the importance of protecting children from SHS in the home in a supportive, non-judgemental manner, as part of their everyday consultations with smoking parents. Furthermore, at the population level, mass media campaigns could be used in conjunction with policy interventions such as smoke-free car laws, and reducing the price of nicotine replacement therapies. Mass media could provide the population with the rationale for smoke-free car laws and effectively advertise nicotine replacement products for use as a cigarette substitute when it is not possible to go outside.

7.7 Limitations & Future work

7.7.1 Survey data

Although population level interventions often do not have a large immediate effect this does not mean that such interventions are ineffective. Long-term evaluations are essential to capture retrospective changes over a longer period of time. Yet, due to the short-term nature of our politics where interventions must be quickly appraised for success in order to satisfy funders, the Government, and their critics, evaluations tend to be rather crude before-and-after studies; such is the case in the evaluation of the regional mass media campaign in chapter 6. In some instances where immediate changes are anticipated (i.e. air quality in pubs and clubs) these types of evaluations are highly appropriate and timely. However, these types of evaluation are not the best methods to use when evaluating intervention impacts on engrained behaviour. Moreover, even the best interventions which plan the evaluation during the planning stages of the research are unable to provide data prior to the conception of their research unless they use data that is already available. Therefore, routine survey data are essential – yet the smoking module of the OS was decommissioned after 2008 which has made it impossible to update the analyses in chapters 3 and 5 at any point in the future. Long-term funding of these surveys is vital and allows researchers from a range of diverse disciplines conduct complex evaluations of pertinent questions.

Despite their usefulness, survey data are not without their limitations. Firstly, researchers are bound by the data available to them. For example the OS does not collect biological measures of SHSe and the HSE asks about what rooms people smoke in but does not ask about whether or not smokers smoke in the same room as non-smokers or children. In addition to this, the questions asked in pre-conceived surveys do not always ask the exact question that researchers would find most useful. Third, representative samples collected by national surveys by definition include fewer smokers in comparison to non-smokers; therefore, the stratification of smoking samples by socio-demographic characteristics, such as measures of SEP, is difficult as sample sizes become much smaller and the results of statistical tests less reliable. Nevertheless, the use of regression analyses has addressed some of these limitations by assessing the associations between socio-demographic variables with the outcomes of interest in the same analyses whilst adjusting for the contribution of other variables. Future population studies of smoking behaviours would

undoubtedly benefit from larger sample sizes. Finally, the most recent data taken from the OS and the HSE are already several years out of date. It is common practice for data from both surveys to be made publically available approximately 18 months to 2 years after the data were collected. For example the 2010 HSE data will not be available until December 2012. Despite their frustrations with this practice, it is important that researchers continue to use these survey data to provide evidence of their utility and to prevent the discontinuation of such surveys.

To date, information on the impact of SHS mass media campaigns is poor. Many evaluations of individual campaigns (such as those described by Kosir and Guiterrez) are before-and-after studies with no control group and no information on previous trends in the outcome of interest. Furthermore, most outcome measures of 'efficacy' of the campaign are not behaviour changes (which are the ultimate goal of the campaigns) but are instead interim measures of campaign reach, such as recall, knowledge changes, attitudes, intention to change, etc. Therefore, it is impossible to comment on the real behavioural efficacy of the majority of anti-SHS campaigns to date. The majority of SHS campaigns do not have published evaluations in academic, peer-reviewed journals and the summary of different SHS campaigns put together by Kosir and Guiterrez found great variability in the quality and completeness of the information provided by SHS mass media campaign leaders. Therefore, it can be argued that the development of a central repository for the impact of mass media campaigns is necessary as a point of reference for researchers and practitioners – a searchable database of public health media campaigns, their specifics and their respective outcome measures.

7.7.2 Managing expectations

The evaluation of the 'Take 7 Steps Out' campaign and the unrealistic impact expected by Tobacco Free Futures highlights a larger issue of the gap between public health research and practice. Knowledge transfer activities need to be incorporated into everyday activity so that dialogue is maintained between researchers and practitioners and vice versa.

There is currently a new project underway to try and assess the independent effect of national anti-smoking mass media campaigns on national smoking prevalence retrospectively over time. It is very difficult to attribute any changes in behaviour directly to

any given mass media campaign, because, if they are being conducted as part of a larger tobacco control strategy, as recommended, then a number of tobacco control interventions will be in operation simultaneously. Smoking prevalence in England has decreased gradually over time alongside mass media campaigns and other tobacco control initiatives. This is positive for tobacco control in terms of synergistic effects but difficult for those trying to apportion any changes in behaviour to individual interventions.

7.7.3 Future work

In line with the ecological approach it is likely that the multilevel model predicting childhood cotinine concentrations post legislation in chapter 4 may have been able to explain more of the variance in children's cotinine levels if community, organisational and societal level factors were included; however such data was not available. Multilevel models are being increasingly used in health research as more academics embrace the ecological approach by acknowledging the role of environmental factors in behaviour change. Therefore it is likely that in the future, greater consideration of how to measure the broader environmental factors that may have an influence on behaviour will occur at the planning stage. In addition to the ecological approach to guide the overall program of intervention, the use of individual level health behaviour theories when planning individual level interventions is recommended within this framework as it is known that interventions based on behaviour change theory have a greater impact on the intended behavioural outcomes (Glanz & Bishop, 2010).

Furthermore, to effectively target those most in need of intervention, smokers from lower socioeconomic circumstances should be consulted in the development of future campaigns which aim to reduce children's SHSe in the home. The Tobacco Control Research Group at the University of Bath currently conducts a bi-annual smoker's panel where research ideas and findings are presented and discussed with a group of approximately 25 smokers. Future interventions could benefit from this type of insight.

While there is some evidence to suggest that those who adopt smoke-free homes are more likely to progress to making quit attempts and in some cases, giving up smoking altogether (Mills, Messer, Gilpin, & Pierce, 2009), it remains unknown whether smokers who continue to smoke but who adopt partial home smoking restrictions later progress to full smoking

restrictions. Future work should use a prospective study design to follow those who currently limit their smoking to one room or abstain from smoking when in a room with a child to see whether this behaviour often progresses to smoking exclusively outdoors or not.

7.8 Final word

Post-legislation in England half of children with smoking parents were exposed to SHS in the home. However, over half of those exposed indoors had parents that limited their smoking to one room only and this had a significant impact on children's cotinine levels. While such parental behaviour does not offer complete protection from the adverse health consequences associated with SHSe, smoking in one room only arguably offers more protection than smoking in more than 2 rooms in the home. Therefore, in addition to those smokers who employed smoke-free homes, a large proportion of smokers were attempting to limit the SHSe of others in 2008 by implementing partial restrictions. To change where parents' smoke (the strongest predictor of children's level of exposure) the evidence in this thesis suggests that smokers require further education on the specific risks of SHS. At present there is no gold standard intervention to achieve significant increases in smoke-free homes among smokers; however, this thesis provides evidence to suggest that a comprehensive tobacco control strategy which incorporates mass media campaigns with a SHS-knowledge raising component is essential.

Given the Coalition Governments' heavy focus on evidence-based public health interventions, this thesis provides timely evidence fuelling the argument for a tobacco control strategy that is consistent with the ecological framework, by adopting a strategy that is multi-faceted and includes the application of interventions at multiple-levels (CDC, 2007). It is only via a comprehensive approach to tobacco control that England will be able to protect future generations of children from the negative impacts of tobacco in the home.

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