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Reducing Families' Exposure to Second-hand smoke in the Home

Reducing Children's Exposure to Second Hand Smoke in the Home

A Literature Review

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A Report by ASH Scotland

Prepared by
April Shaw, Deborah Ritchie, Sean Semple, Stephen Turner, Rachel O'Donnell, Amanda Amos, Lynsey Mills and Inga Wilson

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In preparing this report, ASH Scotland the following members of the REFRESH project management team have contributed to this report:

April Shaw, Senior Researcher, ASH Scotland

Dr Stephen Turner, Clinical Senior Lecturer, Department of Child Health, University of Aberdeen

Dr Deborah Ritchie, Senior Lecturer, School of Health in Social Science, University of Edinburgh

Dr. Sean Semple, Senior Lecturer, Scottish Centre for Indoor Air Environmental and Occupational Medicine, University of Aberdeen

Dr Lynsey Mills, Research assistant**,** University of Aberdeen

Dr Rachel O'Donnell, Policy and Research Manager, ASH Scotland

Inga Wilson, Research Fellow, University of Aberdeen

Professor Amanda Amos, Professor of Health Promotion, Centre for Population Health Sciences, University of Edinburgh

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For Further information on the REFRESH Project or this literature review please contact Rachel O'Donnell (Rachel.ODonnell@ashscotland.org.uk) or go to the REFRESH project website for further updates: www.refreshproject.org.uk

1. Introduction

Reducing exposure to second-hand tobacco smoke[1] is a major health priority for many countries and has led to widespread legislation. The focus now for many policy makers and legislators is to protect children from exposure to tobacco smoke. Reducing second-hand smoke exposure in the home is the most important means to achieving this.

There is a range of research that has explored the issue of second-hand smoke and children's health. This review will identify some of the main findings from the literature. In addition, this review will examine some of the cultural and social barriers and motivators associated with smoking in the home.

The review has been grouped into the following sub-sections concluding with a separate section examining limitations within current research and implications for practice.

- Prevalence of second-hand smoke exposure in the home
- Effects of second-hand smoke exposure on fetal and child health
- The effect of tobacco control legislation on second-hand smoke exposure in the home
- Smoking in the home restrictions and interventions
- Professional views on smoke-free home interventions
- Smoking and stigma

1.1. Methodology

This study includes a review of relevant English language literature (UK and international) relating to children and infants' exposure to second-hand smoke. The papers included in this review were drawn primarily from academic and medical electronic libraries and databases, covering the period from 1994 to 2012. Case studies and non-human studies have been excluded.

The key academic databases that were accessed and searched included Assia, Medline, PubMed and the Cochrane Database of systematic reviews. Additional articles were located through the bibliographies of the selected articles and reviews on the subject of second-hand smoke exposure. Other sites used to search for and access the grey literature were Globalink and ASH Scotland bulletins. Key terms used in the literature search included: secondhand/passive/smok*)/tobacco/parent*/maternal/mother/paternal/father//family /home/ indoor/child(ren)/infants/babies. The key terms were searched within the title and abstracts.

It is acknowledged that the literature search is not extensive and that there are many more papers that workers, academics and other interested parties could cite, nor is it the intention of this review to undertake methodological assessments of the reviewed studies but rather the aim is to give an overview of the key findings and issues concerning second-hand smoke in the home.

[1] **Second-hand smoke** is smoke exhaled by smokers and smoke that comes from the burning end of a cigarette, pipe or cigar, also referred to as passive or involuntary smoke

2. Second-hand smoke in the home

This section reviews and summarises the main findings from the literature review. The first sub-section identifies the prevalence of second-hand smoke exposure in the home. Following this, there is a brief sub-section on smoking and pregnancy and a wider examination of the evidence on the effects of second-hand smoke exposure on children's health. The policy context is then looked at with particular focus on smoke-free legislation and its effects on smoking in the home. Section 2.5 reviews the literature on smoking in the home and smoke-free home restrictions, looking particularly at the barriers and motivators to restricting smoking in the home. Section 2.6 examines briefly smoke-free home interventions while the final two sections looks at some of the challenges identified by professionals in reducing children's exposure to second-hand smoke and examine how the stigmatisation of smoking and smokers may have the unintended consequence of diluting tobacco-related public health messages.

2.1 The prevalence of second-hand smoke exposure in the home

Globally, it has been suggested that almost half (44%) of 13-15 year olds were exposed to second-hand smoke exposure in the home. There is a small difference between those children reporting second-hand smoke at home (43.9%) and those reporting that they have one or more parents who smoke (46.5%) suggesting a close correlation between second-hand smoke exposure at home and population smoking prevalence (IARC, 2009).

In Scotland in 2007, 40% of primary school children reported living with a parent who smokes; 27.4% reported they were exposed to second-hand smoke in the home; 9.5% reported exposure in someone else's home and a further 6.5% reported exposure in a car. While the Scottish smoke-free legislation has made some progress towards promoting health in children by reducing exposure to second-hand smoke in public spaces, less impact has been made on the higher levels of exposure in the home experienced by children whose mother or both parents smoke. Nineteen per cent of children were found to be exposed to second-hand smoke at a level that has been shown to be harmful to arterial health (Akhtar, 2007).

Exposure to second-hand smoke is a particular issue for children in disadvantaged areas where smoking rates are higher than average and cessation rates lower. Socio-economic status has been found to be a predictor of smoking rates, with high rates of smoking associated with unemployment, poor housing, overcrowding, lone parenthood, low income and homelessness (Akhtar et al, 2009; Bolte and Fromme, 2009).

A cross-sectional study of eight annual surveys in England showed that between 1996 and 2006 the overall level of second-hand smoke exposure in children had declined (Sims et al, 2010*)*. Sims et al found that second-hand smoke exposure over time had fallen by 59% over 11 years in observed geometric mean cotinine; from 0.59 ng/ml in 1996 to 0.24ng/ml in 2006 (Sims). However there is some evidence that smoking in the home is more prevalent among low income parents and that smokers from lower social groups tend to smoke for longer durations (onset

to cessation) and are more likely to be heavy smokers compared to higher social groups (Johansson, Halling and Hermansson, 2003; Kaneita et al, 2006; Siapush, Heller and Singh, 2005). Moreover, people in lower socioeconomic groups are less likely to have a total ban on smoking in their homes compared to people in higher socioeconomic groups (Phillips et al, 2007). A study of primary school children after the introduction of smoke-free legislation in Scotland, found a reduction in cotinine levels was greater in children from low income families although they still had higher levels than children from more affluent families (Akhtar et al, 2009). More recently, a repeated cross-sectional survey of 10,867 primary school children in Scotland, Northern Ireland and Wales confirmed the social inequalities in second-hand smoke exposure among children from different socio-economic backgrounds pre and post smoke-free legislation. Using cotinine measures from the children, pooled data from the three countries showed there was no increase in detectable cotinine following the implementation of the smokefree legislation, although second-hand smoke exposure was higher and home smoking restrictions less frequently reported among children from lower socio-economic groups (Moore et al, 2012).

2.1.1 Summary

It is estimated that globally, almost half of 13 – 15 year olds are exposed to second-hand smoke at home and there is a close correlation between second-hand smoke exposure at home and the prevalence of smoking in the general population. While children's second-hand smoke exposure has declined to some degree in the UK there is evidence that smoking in the home is more prevalent among lower socioeconomic status groups compared to higher socioeconomic status groups. While there have been some moves in the right direction in terms of reducing children's exposure to second-hand smoke, action is still required to reduce further the inequalities that currently exist in terms of second-hand smoke exposure in the home.

2.2 Second-hand smoke and pregnancy

Active maternal smoking during pregnancy can increase the risk of a range of conditions, including impairment of foetal growth and development. However non-smoking mothers who are exposed to second-hand smoke may also risk similar effects on foetal and reproductive health, although the risk is smaller than that of smoking mothers.

Almost 19,000 babies exposed to passive smoke during gestation are born with low birth weight each year in the UK (Royal College of Physicians, 2010). Latest figures from Scotland suggest an annual decline in the numbers of mothers reporting smoking at first booking and first visit, though the percentage of women recorded as 'not known' has increased (ISD, 2011). 18.8% of women were active smokers at booking (first antenatal appointment); a decrease of 9% on 2005 figures. Maternal smoking rates at first visit from a health visitor were 18.1% for the same period (a fall from 22.2% in 2005). Mothers in the most deprived categories were more likely to report smoking at first booking compared to mothers from the least deprived (30.6% compared to 6.1%) (ISD, 2011).

Some studies have suggested that babies born to mothers that smoke during pregnancy weigh on average 250g less than babies born to non-smoking mothers whilst babies born to (non-smoking) mothers who are exposed to second-hand smoke may have a reduced birth weight of between 30 – 40g (Royal College of Physicians, 2010). A recent systematic review and meta-analyses of 76 studies that included 50,000 mothers exposed to second-hand smoke and 100,000 non-exposed mothers concluded that mothers who are exposed to second-hand smoke have an increased risk of giving birth to babies that are between 40 – 80g lighter than non-exposed mothers, with a further trend toward low birth-weight (Salmasi, Grady, Jones & McDonald, 2010). Low birth-weight in turn, has been associated with coronary heart disease, type 2 diabetes, and being overweight in adulthood (Lumley et al, 2009). While Salmasi et al suggest that the risks to women exposed to second-hand smoke are 'likely' to be relatively small, the risks may be more significant for those women who are active smokers or have other health conditions that put them at higher risk of poor perinatal outcomes (Salmasi et al, 2010)

In one recent retrospective cohort study the authors analysed Scotland's national administrative pregnancy data in order to assess the impact of Scotland's smoke-free public places legislation on pre-term delivery and small for gestational age (Mackay, Nelson, Haw and Pell, 2012). Analysis of 716,941 cases found that following 1 January 2006 (the introduction of smoke-free public places legislation); there was a significant drop in overall preterm deliveries and a significant decrease in the number of infants born small, and very small, for gestational age. These reductions occurred in both mothers who smoked and those who had never smoked and suggest that the introduction of national, comprehensive smoke-free legislation in Scotland was associated with significant reductions in preterm delivery and babies being born small for gestational age (Mackay et al, 2012).

In an earlier case-control study of 1,154 babies, the researchers assessed the relationship between preterm/early preterm delivery and active smoking as well as second-hand smoke exposure in a sample of pregnant women. Cases of preterm birth were singleton babies born before the 37th gestational week; babies born before the 35th gestational week were considered early preterm births. Controls were babies with gestational ages equal to the 37th week. A total of 299 preterm cases (including 105 early preterm) and 855 controls were analysed. Analysis showed a relationship between active smoking during pregnancy and preterm/early preterm delivery. A dose–response relationship[2] was found for the number of cigarettes smoked daily. For example women who smoked were more likely to have a preterm or early preterm delivery compared to non-smokers and this risk increased with increasing cigarette consumption. In addition, second-hand smoke exposure was associated with early preterm delivery with a dose–response relationship with the number of smokers in the home (Fantuzzi et al, 2007).

Though not conclusive, some studies have argued that maternal passive smoking may reduce fertility, increase fetal and perinatal mortality and increase the risk of some congenital abnormalities (Royal College of Physicians 2010).

[2] A **dose-response relationship** refers to the relationship between the amount of exposure (dose) and the resulting changes in body function or health (response).

The recent publication of the National Institute for Health and Clinical Excellence (NICE) *Quitting smoking in pregnancy and childbirth* guidance aimed at stopping smoking in pregnancy and following childbirth recommended that midwives should identify pregnant women who smoke through discussion and the use of CO tests to assess their exposure to tobacco smoke. This would help identify levels of exposure through both active and passive smoking (NICE, 2010). The NICE guidance also recommended that partners and other smokers in the household should be offered help to stop smoking, as well as information and advice on the risks of passive smoking on the mother and baby.

The *Quitting smoking in pregnancy and childbirth* guide has produced a referral pathway from maternity services to NHS Stop Smoking Services (SSS) and includes a recommendation for reviews of smoking status at later appointments. In addition the guide recommended that other health workers, such as GPs, health visitors and family nurses should also use any appointments with pregnant women as an opportunity to ask them about their smoking status and offer referral to local SSS (NICE, 2010).

2.2.2 Summary

Second-hand smoke exposure during pregnancy may increase the risk of premature birth and contribute to lower birth weight of babies. One study identified an association between premature delivery and the numbers of smokers in the home, suggesting a dose-response relationship among expectant mothers exposed to second-hand smoke. Recent guidance from NICE has recommended the use of CO tests for pregnant women to ascertain levels of second-hand smoke exposure via passive and active smoking. Partners and other smokers living with the expectant mother should also be offered support to stop smoking. The guidance recommends joined-up working between midwives, other health workers, smoking cessation services and other agencies that work with disadvantaged women.

2.3 Effects of second-hand smoke exposure on children's health

Children and infants face the highest level of second-hand smoke exposure in the home as they are often unable to remove themselves from smoky environments. With their smaller airways, faster rates of breathing and immature immune systems children and infants are generally more vulnerable to any adverse health effects compared with adults (Bearer, 2005).

Infants and children inhale double the quantity of household dust compared to adults, and so inhale more dust containing second-hand smoke particulates (Thomson, Wilson and Howden-Chapman, 2005). Infants also have greater hand/object/mouth contact, and so absorb proportionately more second-hand smoke through their digestive system, as well as through their respiratory system (Matt et al, 2004).

A study that examined multiple measures of infant exposure to second-hand smoke in 49 families found that infants in families with smokers who try to protect their child from second-hand smoke (e.g. refraining from smoking in front of the child or smoking outside) are still exposed to between five and ten times more second-hand smoke toxins than in families without smokers. Nevertheless these families do manage to at least halve their infant's exposure when compared to those who take no steps to protect their infants. Dust and surfaces in homes of smokers are contaminated with second-hand smoke and infants of smokers are at risk of second-hand smoke exposure in their homes through dust, surfaces, and air. Smoking outside the home and away from the infant reduces but does not completely protect a smoker's home from second-hand smoke contamination and the infant from second-hand smoke exposure (Matt et al, 2004; Johansson, Hermansson and Ludvigsson, 2004b).

Exposure to second-hand smoke in childhood is associated with reduced lung function, middle ear disease, an increased risk of a range of respiratory symptoms, a higher incidence of respiratory tract infections and Sudden Infant Death Syndrome (SIDS) (SCOTH, 2004; McMartin et al, 2002; Anderson and Cook, 1997; Blair et al, 1999).

The UK Confidential Inquiry into Stillbirths and Death in Infancy estimates that in families where only the father smokes, risk of sudden infant death syndrome (SIDS) is increased 2.5 times. Where both parents smoke, the risk of SIDS is increased almost 4 times (UK Confidential Inquiry into Stillbirths, 2002). A systematic quantitative review of epidemiological evidence relating to parental smoking and SIDS examined the separate roles of prenatal and postnatal exposure. Thirty-nine studies were reviewed and all but one showed a positive association between prenatal exposure and SIDS. However the association between prenatal exposure and SIDS is difficult to determine as most women who smoke during pregnancy continue to smoke afterwards, thus the independent effect of prenatal smoking is difficult to ascertain (Anderson and Cook, 1997)

Second-hand smoke exposure in early infancy increases the risk of serious morbidity from infections. The impact of exposure to second-hand smoke is greater

in low birth-weight and premature babies. A population-based study of 8,327 Hong Kong children found that infants exposed to second-hand smoke in the first three months of life were most vulnerable to infections requiring hospitalisation. Thus the authors conclude reducing household second-hand smoke exposure in infants and particularly more vulnerable babies can reduce infectious morbidity and hospitalisation (Kwok et al, 2008*).*

Exposure to second-hand smoke in childhood is associated with reduced lung function in children (SCOTH, 2004), a higher incidence of respiratory tract infections including bronchitis, bronchiolitis, croup and pneumonia, and an increased risk of respiratory symptoms such as breathlessness, phlegm, coughing and wheezing (Bradley et al, 2005). A recent systematic review and meta-analysis of 60 studies concluded that exposure to second-hand smoke, in particular via maternal smoking, caused a statistically significant increase in the risk of children younger than two years of age developing lower respiratory infections (LRI), especially bronchiolitis (Jones et al, 2011).

Furthermore, exposure to second-hand smoke can cause asthma in children, and may increase the severity of the condition in children who are already affected (Mannino, Homa and Redd, 2002; Strachan and Cook, 1998). Second-hand smoke is cited by up to 80% of asthmatics as a trigger for further attacks (National Asthma Campaign, 1996). A systematic review and meta-analyses of 71 studies suggests pre- or post-natal exposure to second-hand smoke may account for an increased risk of wheezing and asthma (Burke et al, 2012). The authors calculate that exposure to pre-or post-natal second-hand smoke exposure is associated with a 30 – 70% increased risk of incident wheezing, with the strongest effect from post-natal maternal smoking on wheeze in children aged less than 2 years. They also found a 21% to 85% increase in incident asthma with the strongest effect from pre-natal smoking on asthma in children less than 2 years old (Burke et al, 2012).

It is estimated that in the UK over 7,000 new cases of wheeze in children aged less than 2 years and over 15,000 new cases of asthma in children over the age of 3 is due to second-hand smoke exposure (Royal College of Physicians, 2010). Children with asthma whose parents smoke at home are at least twice as likely to have asthma symptoms all year compared to children of non-smokers (Slish et al, 2004) while exposure to second-hand smoke is associated with increased sleep problems among children with asthma (Yolton et al, 2010).

In one study which explored vascular damage in young adults, Geerts et al (2008) collected birth data and ultrasound measurement of common carotid artery intima-media thickness (CIMT) from a cohort of 732 young adults. Offspring of mothers who smoked had thicker CIMT than offspring of mothers who did not smoke in pregnancy. Thicker CIMT was associated with exclusive paternal smoking in pregnancy, somewhat stronger with exclusive maternal smoking and strongest with both parents smoking. Thus permanent vascular damage is partly attributable to familial tobacco smoke exposure, an association that might be initiated in gestation (Geerts et al, 2008).

Exposure to second-hand smoke can cause middle ear disease, including recurrent ear infections in children (Hinton and Buckley, 1988; Strachan, Jarvis and Feyeraband, 1989; American Academy of Paediatrics, 1997). A study of over 32,000 children found that there was a slightly higher risk of middle ear infection in early childhood when children were exposed to tobacco smoke both pre- and post-natal (Håberg et al, 2010). In an earlier study of almost 12,000 children, Lieu and Feinstein (2002) found that the occurrence of any ear infection was not increased by passive postnatal smoke exposure, but was slightly increased by antenatal smoke exposure. However the risk of recurrent ear infections was significantly increased with combined antenatal and postnatal smoke exposure (Lieu and Feinstein, 2002).

A systematic review and meta-analysis of 61 epidemiological studies suggests exposure to second-hand smoke, particularly to smoking by the mother, increases the risk of middle ear disease in childhood and specifically increases the risk of middle ear disease requiring surgery (Jones et al (2012). Furthermore the authors show that annually over 130,000 cases of child middle ear disease in the UK are directly attributable to second-hand smoke exposure in the home (Jones et al, 2012).

Recent data suggests that parents may have little knowledge about the specific health risks to children that are associated with second-hand smoke exposure. A cross-sectional survey of 318 households in Leeds with at least one child under 16 showed the majority of participants were aware of the adverse impacts of second-hand smoke exposure, regardless of whether they smoked or not. However when asked about the adverse potential health impacts of exposure to second-hand smoke on children, most listed non-specific effects such as ‘breathing problems’ and ‘passive smoking’ (Alwan et al, 2009). Similar findings elsewhere have documented poor knowledge of specific illnesses although there is awareness of the general consequences of second-hand smoke exposure (Johansson, Hermansson and Ludvigsson, 2004a; Robinson and Kirkcaldy, 2007a).

Tobacco smoke exposure has also been associated with behavioural problems, reduced intellectual ability, hyperactivity , decreased attention span, language skills and grade retention (Braun et al 2006; Huiznik and Mulder, 2005; Kukla et al, 2008; Yolton et al, 2005). Nevertheless some caution is required as research in this area is relatively scarce and the causes and risk factors for behavioural problems and learning disabilities are relatively poorly understood (Thapar et al, 2009; Anderko et al, 2010).

A further effect of tobacco exposure on children is that children of smokers are themselves more likely to become smokers (Sherman et al, 2009; den Exter et al, 2004; Jackson et al, 1998; Vink, Willemsen and Boomsma, 2003). A Scottish survey of 10,063 school pupils showed that pupils who smoke are more likely to have parents who are smokers than non-smoking pupils (Ipsos MORI, 2009). Breaking a family history of smoking is one of the most important actions a parent can do to improve their child’s wellbeing and life span.

2.3.1 Summary

Children and infants face higher levels of second-hand smoke exposure in the home than adults due to their inability to remove themselves from smoky atmospheres and their faster rates of breathing. Not only do they inhale more dust containing second-hand smoke particulates, they will also ingest greater quantities. It is estimated that even where smoking parents restrict smoking in front of the child, the child's exposure to the toxins in second-hand smoke is still 5 to 10 times greater than a child from a non-smoking household. Where no restrictions are put in place, the exposure is greater still.

Exposure to second-hand smoke in childhood is associated with a range of illnesses including reduced lung function, middle ear disease, a higher incidence of respiratory tract infections and Sudden Infant Death Syndrome. Furthermore children with asthma may be affected more severely when exposed to second-hand smoke. The studies which link exposure to health outcomes have taken socioeconomic factors into consideration, i.e. the relationship is not only explained by children from less affluent communities being at increased risk for both exposure to tobacco smoke and respiratory tract symptoms. Some research has suggested a link between smoking during pregnancy and behavioural problems in children however the evidence is tenuous and more research is required to establish the strength of this association.

While there is a broad understanding of the general health effects of exposure to second-hand smoke, parents generally have less knowledge of the specific health effects of second-hand smoke exposure on children's health. Nevertheless, parents can improve the health of their children, grandchildren and all subsequent generations by breaking the family tradition of smoking.

2.4. Smoke-free legislation

The introduction of the 2006 smoke-free legislation[3] for public places in Scotland served as an important milestone in reducing the adverse impact tobacco has on health. Research conducted since the introduction of this legislation has emphasised the positive effects of the law, but also highlighted the fact that work must continue to reduce exposure to tobacco smoke, particularly for vulnerable groups (including children) in areas not covered within the legislation, such as the home (Akhtar et al, 2007).

The introduction of smoke-free legislation in the UK occurred first in Scotland in 2006, followed by Wales, Northern Ireland and England in 2007. The legislation made it illegal to smoke in enclosed public areas and places of work. There are broadly five exemptions from the legislation: specified workplaces, residential institutions, Crown bodies and property, diplomatic premises and private dwellings.

[3] For further information on tobacco control legislation in Scotland go to http://ashscotland.org.uk/ash/4263.html

Since the introduction of smoke-free legislation, there has been a significant reduction in second-hand smoke exposure, particularly among workers in the hospitality industries (Royal College of Physicians, 2010; Callinan et al, 2010). A recent study by Apsley & Semple (2011) compared second-hand smoke levels measured in 2006 (post smoke-free legislation) and 2011 in 39 bars in two Scottish cities. Fine particulate matter ($PM_{2.5}$) was measured in each bar in May/June 2006 and again, in the same bars at during the same period and at the same time of day, in 2011. The average $PM_{2.5}$ levels measured in 2011 (total of 51 bar visits) were 12 μ/m^3 compared to 20 μ/m^3 in 2006 post legislation. Fine particulate concentrations were comparable to outside ambient air in all but two visits in 2011. The findings show that compliance with the smoke-free legislation remains high in Scotland and that the legislation continues to offer important protection from second-hand smoke exposure for both bar workers and customers (Apsley & Semple 2011).

Self-reported improvements in adult respiratory health have been documented, as have reductions in hospital admissions for coronary heart disease following smoke-free legislation (Pell et al 2008; Richiardi et al, 2009; Lightwood and Glantz, 2009). One systematic review of 11 reports suggests that community smoking bans are associated with a 17% reduction in Acute Myocardial Infection incidence (Meyers, Neuberger and He, 2009). Reductions, post-legislation have also been observed in hospital admissions for respiratory conditions (Naiman, Glazier and Moineddin, 2010).

The Netherlands smoke-free legislation has not been as successful in terms of compliance as the UK experience. A failure on the part of policy makers to fully explain to the public the health benefits of smoke-free hospitality venues and poor implementation of the smoke-free ban allowed opponents to gain the upper-hand in terms of public and media support for encouraging non-compliance and exempting some businesses (such as small, owner-run bars) from the smoke-free legislation (Gonzalez and Gantz, 2011). The authors argue that the failure for the successful implementation of smoke-free regulations in the Netherlands was largely the result of the government's failure to anticipate opposition to the law, defend the legislation as a way to protect non-smokers and allowing partial exemptions that undermined the public's perception of smoke-free regulations.

2.4.1 The effect of tobacco control legislation on second-hand smoke exposure in the home

Reducing the prevalence of smoking among parents and carers is the most effective way to prevent second-hand smoke exposure in children. Legislation relating to tobacco control policies, including tax increases, mass media campaigns, health warnings, cessation services and smoke-free policies has contributed to an overall reduction in smoking prevalence among all adults in the UK, from 40% in 1978 to 21% in 2007 (Office for National Statistics, 2007). In Scotland, non-smokers' exposure to second-hand smoke in the home has decreased markedly from 1998 to 2008: from 18% to 10% for men and women. Exposure in other people's homes has also declined from 21% to 12% for men, and 25% to 13% for women (Scottish Health Survey, 2008).

Smoke-free legislation is associated with fewer adults remaining smokers and lower levels of smoking more generally (Farrelly, Evans and Stefakas, 1999; Hovell et al, 2000). A systematic review of 26 studies in the United States, Australia, Canada and Germany on the effects of smoke-free workplaces found that totally smoke-free workplaces are associated with a decrease in smoking prevalence of 3.8% (95% confidence interval 2.8% to 4.7%) (Fichtenberg and Glantz, 2002). Research also demonstrates that where smoke-free workplaces and enclosed public places are the norm, parents are more likely to try and prevent smoking in the home (Borland et al, 1999; Soliman et al, 2004).

The home remains an important source of second-hand smoke exposure for some children and they are particularly vulnerable to the adverse health effects of second-hand smoke. They have little control over their environment and may not be in a position to remove themselves from second-hand smoke exposure (Ashley and Ferrence, 1998). Encouraging parents and carers to implement smoke-free policies in their homes is an important complement to general population strategies to reduce smoking prevalence and protect the health of children. However legislating against smoking in the home would be likely to encounter considerable opposition. Not only would such a strategy require substantial public support it would require enforcement which would be both costly and difficult to implement (Royal College of Physicians, 2010).

Opponents of smoke-free legislation often argue that an immediate consequence of introducing smoke-free public places is increased smoking in the home. This argument is used to attempt to justify a voluntary approach to reducing exposure to second-hand smoke. Yet, despite these concerns evidence to date suggests that any displacement of smoking in public places to smoking in the home has not occurred (Fong et al, 2006; Akhtar et al, 2007; Edwards et al, 2008; Holliday, Moore and Moore, 2009; Callinan et al, 2010).

The most recent paper to measure changes in the prevalence of home smoking bans among smokers in four European countries (Ireland, France, Germany and the Netherlands) after the implementation of national smoke-free legislation concluded that smoke-free legislation has not led to increased smoking in private homes. The authors argue that instead, their findings demonstrate that smoke-free legislation may in fact encourage smokers to establish total smoking bans in their homes. For example, at baseline (pre-legislation survey) most smokers had at least partial smoking restrictions in their home. At follow-up (post-legislation survey), there was an increase in the proportion of total home smoking bans in all four countries and a decrease in the proportion with no smoking restrictions (Mons et al, 2012).

Fifteen studies examined in a recent Cochrane review which measured second-hand smoke exposure in the home following smoke-free legislation also found that in general there was no displacement of smoking in to the home after the ban and a few studies did report increases in total home smoking bans (Callinan et al, 2010). For example, in Ireland post-legislation, there was an estimated two to five percent decrease in the proportion of Irish homes where smoking was allowed (Fong et al, 2006; Kabir et al, 2009). Similar increases in smoke-free homes were indicated in California and New Zealand (Gilpin et al, 2002; Waa and McGough, 2006).

In California, the proportion of children and adolescents living in smoke free homes increased from 38% in 1992, to 82.2% in 1999, one year after all enclosed public places and workplaces became smoke-free state-wide. Importantly, in homes where all adults smoked, smoke free homes increased from 8% to 53% over the same period. In homes where at least one adult smoked the proportion of smoke-free homes increased from 33% to 67% (Gilpin et al, 2002).

Initial data from New Zealand confirmed that one year post smoke-free legislation, the percentage of people reporting second-hand smoke exposure in their home had reduced from 20% to 14.7% (Ministry of Health New Zealand, 2005). The New Zealand data also demonstrated that individuals who work in a smoke-free environment are more likely to discourage visitors from smoking in their home, compared to respondents whose workplaces have partial or no smoking restrictions (Gillespie, Waa and Afzal, 2004).

Akhtar et al surveyed 2,527 primary school children one year after the implementation of Scotland's smoke-free legislation. The proportion of primary school children reporting a complete ban on smoking in their home, as opposed to partial or no restrictions, increased independent of parental smoking status, from 47% to 52%. However, children who reported living with smokers were less likely to have 'stringent restrictions' at home compared with children who lived with non-smoking parents. Among the smoker households the extent of restrictions varied according to the number and gender of parents who smoked. For example those living in households where only the father smoked were more likely to live in a house with a complete smoking ban compared to those children living with two parents who smoke or only a mother who smokes (Akhtar et al, 2009).

However the home remains the primary environment where second-hand smoke exposure is likely to be highest for children and parents and carers require specific information on the health effects of second-hand smoke exposure (Alwan et al, 2009).

2.4.2 Summary

Smoke-free legislation in the UK and abroad has contributed to a reduction in second-hand smoke exposure among workers and the public generally. Where smoke-free legislation has been implemented, improvements in respiratory health and reductions in coronary disease have been documented and some studies have shown a reduction in smoking in the home, with parents and carers more likely to attempt prevention of smoking indoors although there is still some debate around the impact. Nevertheless where implementation of smoke-free regulations are weak, opponents can gain the upper-hand in terms of changing public attitudes and encouraging non-compliance thus undermining the law and allowing for an increase in exemptions that lessens the effectiveness of smoke-free policies.

2.5 Smoking in the home

According to the behavioural ecological model (BEM), smoking and passive smoking are behaviours which are influenced by the interaction of physiological, cultural and environmental factors (Hovell, Wahlgren and Gehrman, 2002). While such factors may combine to promote smoking they can also produce values that oppose smoking and reinforce the avoidance of tobacco. Cultural factors at the community level, such as media exposure and social networks may be particularly important in protecting children from second-hand smoke exposure, especially if they are suffering from ill-health such as asthma. Legislative policies and penalty systems can reinforce community-wide reactions to tobacco use and child exposure. For example restrictions on public building smoking policies may prompt changes in smoking in private dwellings, such as homes, thus families may be susceptible to cultural norms prohibiting second-hand smoke exposure (Hovell and Daniel, 2005).

Policy options that could positively affect the prevalence of smoke free homes are improvements in mass media campaigns; improving the confidence and ability of people to negotiate smoke free places; increasing tobacco prices; improving the effectiveness of smoking cessation services, and ameliorating the impact of socioeconomic deprivation (Thomson, Wilson and Howden-Chapman, 2006).

Mothers living in disadvantaged areas are most often the primary carers of children therefore it is essential that any interventions should ensure they take into account the social, economic and environmental circumstances of these parents. Recent qualitative work has identified the ways in which mothers present and conceptualise their smoking behaviour that do not fit the usual definitions of 'smoking' and 'smoke-free' homes. Robinson and Kirkcaldy (2007a), found that smoking mothers in non-smoking homes often made exceptions to their rules and smoked inside; while mothers who described themselves as 'smoking everywhere' imposed some form of self-restriction. Furthermore smoking behaviours can change over the course of a day, week or longer, depending on the social and physical environment at the time. The authors argue that it is important that professionals consider the changing nature of parents' smoking habits and do not accept uncritically parents' statement about smoking and non-smoking homes (Robinson and Kirkcaldy 2007a).

A UK cross-sectional study by Spencer et al showed lower cotinine levels for families who restrict smoking in their homes. A community based survey of children aged 18-30 months was conducted to test the hypothesis that independent of household cigarette consumption, socioeconomic status and overcrowding, *not smoking in the home* was associated with a statistically significant reduction in children's smoke exposure. The study which included 309 smoking households indicated that only a small proportion of households reported a complete smoking ban to protect their children from second-hand smoke exposure; the majority used less strict measures to limit exposure. The results showed that only a complete ban on smoking in the home was independently associated with a reduction in smoke exposure, as measured by urinary cotinine. Less strict measures appeared to have no effect on children's second-hand smoke exposure (Spencer et al, 2005).

Earlier research conducted by Johansson et al (Johansson, Hermansson and Ludvigsson, 2004b) whereby urine cotinine measures were analysed from pre-school children of smokers and compared with a control group of pre-school children from non-smoking homes, showed that smoking outdoors with the door closed was not a totally effective way to protect children from second-hand smoke exposure. However, when compared to other restrictions, such as smoking by an open window/door or near a fan, smoking outdoors was the most effective way of protecting children from second-hand smoke exposure. For example, non-smoking households as the control group had an (odds ratio) exposure score of 1.0; outside smoking with the door closed gave an exposure score of 2.0; for standing near an open door plus outdoors an exposure score of 2.4; for standing near the kitchen fan plus outdoors an exposure score of 3.2; for mixing restriction methods - near an open door, kitchen fan, and outdoors an exposure score of 10.3; and for indoor smoking an exposure score of 15.2.

2.5.1 Smoke-free home restrictions

Research in the UK and elsewhere has explored the barriers and motivators to restricting smoking in the home. Despite public health messages, awareness of the health risks of second-hand smoke exposure do not necessarily result in reducing smoking in the home (Blackburn et al, 2003; Priest et al, 2008; Robinson and Kirkcaldy 2007a). Factors that may affect smoking restrictions in the home include social, economic, cultural and environmental influences.

Parents often state that smoking provides stress relief and helps to defuse difficult domestic situations (Graham, 1993). Furthermore the need to protect children's health may be set against competing demands, such as the need to relax and maintain social relationships, as well as the need to be actively present to care for the child and prevent harm (Robinson and Kirkcaldy 2007a).

Parents living in poor housing or areas of deprivation may consider other environmental pollutants to be as harmful for children as second-hand smoke (Northridge et al, 2009). Furthermore, lack of suitable space outside the home to smoke may inhibit parents' attempts to restrict smoking in the home; this is especially important for smokers living in flats who may not have access to outdoor space, such as a verandah, and cannot leave young children unsupervised (Ritchie et al 2009; Hill, Farquharson and Borland, 2003). However, parents may choose strategies to reduce second-hand smoke exposure that they see as practical; such as opening windows, smoking in a separate room, and smoking in a room with a fan or holding the cigarette out of the window (Hill, Farquharson and Borland, 2003).

Comfort is a major reason for smoking indoors. Going outside to smoke is not as relaxing and 'consoling' as smoking inside, particularly during winter months. Thus a reported desire to have a smoke-free home may not actually outweigh the perceived benefits of a smoker's sense of relative comfort and well-being when smoking indoors. Therefore to encourage a reduction in second-hand smoke exposure requires an understanding of the role of comfort, pleasure and social factors, and the need to provide social support for people who rely on smoking to get through what may be relatively difficult lives (Hill, Farquharson and Borland, 2003).

Parents, and mothers in particular, may find it difficult to restrict visitors smoking, particularly those family and friends who may be providing childcare. In addition, mothers who live with other smokers may have to negotiate smoking restrictions and may not be supported by their partners, who either break the rules or complain about complying (Hill, Farquharson and Borland, 2003; Bottorff et al, 2006; Robinson and Kirkcaldy 2007a; Wilson et al, 2012b). Furthermore, smoking cessation products such as nicotine replacement therapy may be perceived as prohibitively expensive, particularly among smokers living in England who are above the financial threshold for free prescriptions (Hill, Farquharson and Borland, 2003).[4]

Parental attitudes to second-hand smoke exposure are to a degree, determined by smoking status. One Swedish study found that indoor smokers were less convinced than outdoor or non-smokers that second-hand smoke exposure causes adverse health effects (Johanssen et al, 2004a). In a study of smoking parents of hospitalised children (21% admitted with respiratory illnesses), 41% of smoking parents disagreed that their smoking had a negative effect on their child's health (Winickoff et al, 2001).

Parents who smoke may often be aware of the short-term risks to children's health from passive smoking but may actively resist these messages using primarily four sources of knowledge; their observations of their own children; their observations of other people's children; reflections on their own health as children of smoking parents; and information from other relatives (Robinson and Kirkcaldy 2007b).

Resistance to health messages that link childhood illnesses such as asthma with smoking may form part of an underlying theme that smokers, and particularly smoking mothers, are being 'unfairly' blamed for harming their children. By negating the possible harms, and discrediting the sources of information and redistributing blame, mothers are able to reconcile any feelings of guilt and pressure to stop smoking by referring to explanations that make it easier for them to reconcile their smoking and (re-) construct their moral identity as caring mothers (Robinson and Kirkcaldy 2007b).

One of the gaps in the research is that very little is known about how restrictions in the home are negotiated, established and enforced (Bottorff et al, 2006; Poland et al, 2009). A Scottish study of 50 smokers and non-smokers living with smokers found there was a range of restrictions in households ranging from total bans inside the home to no restrictions at all, and that these restrictions were themselves not static but fluid and open to modification (Phillips et al, 2007). Smokers who lived only with smokers or on their own were more likely to report no restrictions and smokers from the lowest socioeconomic band were least likely to have a total smoking ban in the home. Respondents with partial or no restrictions would however modify the restrictions depending on circumstances. For example, restrictions would become stricter if children were present, or relaxed if other smokers were visiting. Aesthetics (smell of smoke), health (particularly concerns around children's health), pressure to not smoke from other family members, and concerns about modelling

[4] In Scotland, Wales and Northern Ireland prescriptions are free of charge. In England those who are eligible for benefits or who are on low incomes are able to access free prescriptions. Currently in England, a 12 week supply of prescribed NRT products will cost £29 through a prescription pre-payment plan.

smoking behaviour in front of children were the most common reasons for restricting smoking in the home. Importantly most of those interviewed suggested changes to home smoking restrictions presented few challenges and little conflict. Some former smokers expressed concerns as to how they would be *perceived* by others if they restricted smoking. These concerns were largely related to being regarded as anti-smoker, hypocritical and inconsiderate. Social identity (whether one considered oneself to be a 'considerate' smoker or non-smoker) was important and this played a pivotal role in the modification of behaviour and restrictions for family and friends visiting the home. In addition moral identities were constructed around being a caring parent, grandparent or adult, as protecting children from the health risks associated with second-hand smoke exposure was the main reason cited for increasing restrictions or implementing total bans (Phillips et al, 2007).

In a study that explored the motivators and barriers to smoke-free homes among 22 disadvantaged caregivers, Jones et al (2011) found that knowledge and understanding of the dangers of second-hand smoke were incomplete and confused. Similar to the findings of Phillips et al (2007) home smoking restrictions were fluid and open to change, depending on circumstances. There appeared to be two main reasons for this fluidity of home smoking rules. Firstly, changing perceptions of risk and secondly a conflict between caring for a child and the desire to smoke. In terms of risk perceptions, several caregivers had initiated smoke-free homes at the birth of a child but as the child grew older the perceived risks associated with second-hand smoke exposure diminished (Jones et al, 2011). The desire to smoke and difficulty in maintaining a smoke-free home is supported by evidence elsewhere that has shown that caregivers (and mothers in particular) living in disadvantaged circumstances find it difficult to 'cope' with childcare responsibilities in relatively difficult economic and physical environments, and that smoking is a mechanism for taking time out and relaxing (Graham, 1993; Robinson and Kirkcaldy 2007a; Burgess, Fu and van Ryn, 2009). Furthermore, their daily lives may have many conflicting priorities and changing smoking behaviours in the home would be low on the list, if there at all (Jones et al, 2011). Further barriers to change included, negative reactions by others (such as being viewed as a hypocrite) which may impact on their relationships (particularly with other members of the household or friend s and family who may also provide essential support and free childcare); habit, addiction and boredom; and the desire to smoke in comfort, privacy and a safe environment. The primary motivator for changing smoking behaviours in the home was aesthetic (decor and smell). Child health, reducing the risk of children becoming smokers and a desire to quit smoking were further motivators to change. While the authors call for tailored support and information in order to reduce children's second-hand smoke exposure they also suggest that providing demonstrable evidence of the impact of smoking on children's health would be an effective way to instigate behaviour changes in disadvantaged caregivers (Jones et al, 2011).

In a qualitative study designed to investigate the nature of social arrangements in the home as they relate to the management of second-hand smoke, 15 in-depth interviews were supplemented by observational data on the participants' home environment (Poland et al, 2009). The researchers found that in some cases informal controls on smoking in the home evolved over a period of time. Two types

of trigger events could lead to changes in behaviour; for example 'opportunity' type trigger events included the arrival of a new baby or moving to a new home, or 'last straw' trigger events such as the identification of a severe or chronic illness linked by a health professional to second-hand smoke. Within the study they found three degrees of restrictions in the home: low, moderate and high[5]. The variability within households suggests that a 'one-size fits all' approach may not be as effective as one that is tailored to the level of current restrictions in the home or current household and social dynamics. The findings suggest that second-hand smoke exposure reduction measures may often be a step in a longer-term progression towards a smoke-free home (Poland et al, 2009). While there is some evidence that there are no safe levels of second-hand smoke exposure, Poland et al argue that such evidence must be set against the reality that for some households a complete ban may not be feasible. Therefore some health gains may be realized through gradual reductions in intensity or duration of second-hand smoke exposure. Emergent health discourses enacted at home are an opportunity for positive changes in relation to second-hand smoke exposure but they may also represent new opportunities for discord among family members. In particular, limiting second-hand smoke exposure in a home where both parents smoke may be more challenging. As a consequence, different tailored educational and support strategies may be required to deal with the relational dynamics associated with reductions in smoking in the home and smoking cessation. Interventions that operate implicitly from a stance of high risk management may unintentionally alienate or fail to motivate members of a household who may have a low risk stance toward second-hand smoke (Poland et al, 2009).

Bottorff et al (2006) explored the dynamics between couples during pregnancy and the postpartum period, specifically when the mother was attempting to reduce or cease smoking. Three tobacco-related interaction patterns were identified: couples with 'disengaged tobacco-related interactions' treated tobacco use primarily as a personal decision and individual activity and did not negotiate their tobacco use with each other; 'conflicted tobacco-related interactions' were characterised by shaming, coercion, monitoring and hostility; and couples with 'accommodating tobacco-related interactions' were motivated to reach agreements about tobacco use and shared tobacco reduction goals. An awareness of potential health risks to the foetus and the stigma associated with smoking during pregnancy brought about expectations for cessation by both the women and their partners. These expectations created the condition of 'compelled' tobacco reduction. The challenge therefore of 'compelled' tobacco reduction revealed differences in the couples' ability to work together as a unit. For couples with accommodating tobacco-related interactions, the pregnancy brought together a shared understanding of the roles each would play to ensure tobacco reduction for the woman (Bottorff et al, 2006).

Compelled tobacco reduction was felt most intensely by women who experienced conflicted tobacco-related interactions with their non-smoking partners. Partners were said to become more persistent and confrontational with their demands for

[5] According to the typology a *Low* degree of restrictions on smoking in the home indicates a lack of consistent effort; *Moderate* degree of restrictions on smoking in the home indicates segregated areas inside the home; and a *High* degree of restrictions on smoking in the home indicates a complete ban on smoking inside the home.

cessation. Nevertheless, the reduction in tobacco use by women also initiated a process of reducing conflict in the longer term. The reduction in conflict was a powerful incentive for women to continue their cessation/reduction efforts (Bottorff et al, 2006).

In partnerships characterised by disengaged tobacco-related interactions, women prior to pregnancy did not have their smoking challenged by their partners however once they became pregnant, they experienced pressures to reduce tobacco use. This change in dynamics changed the way couples spent time together and interrupted patterns of intimacy. The women experienced varying levels of resentment over both the policing they had to do to establish smoke-free homes and the inequities they felt as their partners continued to smoke. The result was that women became increasingly separated physically and socially from their smoking partners. As a consequence the women experienced heightened feelings of isolation as they reduced or gave up smoking for their pregnancies (Bottorff et al, 2006).

The authors conclude that the pressure on pregnant women to reduce or stop smoking to varying degrees suggests that domestic spaces may not provide 'sanctuaries' from social scrutiny and pressures to be smoke-free. The basic social condition of compelled tobacco reduction for pregnant women and its central focus on protecting fetal health could explain why smoking cessation during pregnancy is often not an autonomous and sustained behaviour change. Based on the study findings, it cannot be assumed that all women are able to discuss tobacco reduction with their partners or are able to enlist meaningful partner support for cessation without increasing the risk for interpersonal conflict. The concept of compelled tobacco reduction and the typology of couple based tobacco-related interaction patterns may provide a useful framework for examining experiences of smoking cessation and designing smoke free homes intervention messages for women and their partners (Bottorff et al, 2006).

2.5.2 Summary

Smoking tobacco is influenced by the interaction of physiological, cultural and environmental factors which can help promote or resist smoking. Professionals need to remain aware of the factors that can act as barriers or motivators for smoking in the home. For example, smoking can provide stress relief for parents, and as such the need to relax and engage socially with others may outweigh the perceived benefits of smoking restrictions in the house. Furthermore smoking restrictions may need to be negotiated within some households and this can be a difficult barrier for some parents motivated to change smoking behaviours. Studies in the UK and elsewhere have shown that many smoking caregivers will have some form of smoking restriction in the home (across all social classes) however this is often fluid and dynamic, open to changes over time and circumstance. Although many smoking parents may be motivated by their child's health, the primacy of this motivating factor may diminish as the child grows older. Furthermore, despite health messages on the effects of active and passive smoking, there still remains a lack of knowledge or acceptance of these messages among some parents. Parents living in deprived areas may consider other external factors, such as poor housing or environmental pollutants as harmful to child health as second-hand smoke exposure. Furthermore, observations of their own or other people's children and experiences may contradict

health messages. As such, interventions aimed at reducing smoking in the home should take into account the social, economic and environmental circumstances of parents and carers.

2.6 Smoke-free home interventions

A number of interventions have explored a variety of methods to reduce second-hand smoke exposure in the home and more generally in the wider environment. The range of interventions have adopted different theoretical approaches such as those based on behavioural change, self-efficacy or educational strategies. Some have used counselling while others have included personalised information such as feedback on air quality in the home or cotinine measures. Some have looked at effecting change in ill-child cohorts whilst others have been aimed at all children; some have targeted samples of all ages while others have restricted their interventions to babies and infants. Interventions have been tested in clinical or community settings, and delivered by clinical staff such as nurses or paediatricians; research staff or community workers.

Three critical reviews have examined a range of interventions to reduce children's second-hand smoke exposure based on different criteria. Gehrman and Hovell (2003) examined 19 interventions based on empirical evidence from 1987 – 2002. They examined interventions that aimed to reduce second-hand smoke exposure in children (birth – 17 years). Priest et al (2008) reviewed 36 studies and included all mechanisms for reducing second-hand smoke exposure among children up to 12 years including interventions and legislation. They limited their review to controlled studies (with or without random allocation) only. The most recent paper by Baxter (2011) reviewed the effectiveness of 17 interventions aimed at establishing smoke-free homes during pregnancy and the neonatal period (< 12 months) with no limit on the study designs.

The outcome measures of the reviewed studies included self-reported parental behaviour change (Gehrman and Hovell, Priest et al, Baxter); biochemical measures (Gehrman and Hovell, Priest et al, Baxter); child illness (Gehrman and Hovell, Priest et al); and use of health services (Priest et al). Combining the findings from the three reviews the authors identified 21 statistically significant effective interventions. However, they suggested the evidence for recommending one intervention type over another is mixed due to the variability between studies in both design and quality, as well as inconsistencies in measurements and delivery. Moreover many studies have used comparison groups rather than control groups (i.e. no intervention at all including advice or information) which may have had a confounding effect on the statistical significance of the interventions tested.

In this section we critically review 23 peer-reviewed studies (Table 1) measuring the effectiveness of smoke-free home interventions focussing on:

- Interventions in ill-child populations
- Delivery settings
- Theoretical approaches

The review also identifies the implications for future research in this area.

Interventions in ill-child populations

Although it could be assumed that parents of sick children might be more motivated to reduce second-hand smoke exposure in the home than parents of healthy children, Gehrman and Hovell (2003) found no clear evidence for this hypothesis. Gehrman and Hovell identified a significant reduction among four out of eight interventions that targeted parents of asthmatic children compared to six out of 11 well-child interventions. Priest et al (2008) also identified eight studies specifically aimed at improving ill-child health outcomes, of which two had a significant effect.

Among the 23 papers examined for this review, eight were specifically aimed at ill-child populations (notably respiratory problems including asthma). Three studies showed no significant difference in the populations studied (Wakefield et al, 2002; Ralston and Roohi, 2008; Winickoff et al, 2003), although two of these studies did show positive (though non-significant) results. For example Wakefield et al (2002) reported an increase in home and car smoking bans, whilst Winickoff et al (2003) reported an increase in parent quit attempts and a decline in the mean number of cigarettes smoked in the home.

Among the five ill-child studies that did show a statistically significant effect on one or more outcomes, only one was based in the home (Lanphear et al 2010) with the remainder in the clinical setting (Chan and Lam, 2006; Hovell, Meltzer and Zakarian, 1994; Wilson, Yamada and Sudhakar, 2001; Wilson et al, 2011).

Wilson et al (2001) examined the effect of an intervention targeting smoking behaviour change on the use of health care services using three nurse-led sessions spaced over five weeks, with feedback on children's urinary cotinine levels and using behavioural change strategies and basic asthma education that emphasised a reduction in second-hand smoke exposure. The study demonstrated a significant reduction in the prevalence of children in the intervention group making more than one acute care asthma visit in the year following the intervention and a 46% greater reduction in the urinary cotinine/creatinine ratio (CCR) in the intervention group compared to the control group. There was a small change in the amount of cigarettes smoked although no significant group difference. The authors suggested the asthma education component was more effective in reported health benefits than the smoking behaviour programme (Wilson et al, 2001).

In an earlier study by Hovell et al (1994) the intervention aimed to reduce second-hand smoke exposure among 91 asthmatic children with smoking parents. The experimental/counselling group (ECG) received a six month series of counselling sessions designed to reduce second-hand smoke exposure. Behaviour modification techniques such as stimulus control, shaping and personal feedback was tailored to each family. The ECG also used diaries during each two week monitoring period preceding clinic visits to record smoking patterns and the child's exposure to second-hand smoke, children's peak flowmeter readings and children's symptoms. The monitoring control group (MCG) used the same monitoring measures as used in the ECG but were not provided with a review of records or counselling. A usual treatment control group (CG) participated in the same sequential clinic visits as the other groups but was not asked to monitor cigarette use, second-hand smoke

exposure or children's symptoms, although they did record children's peak flowmeter readings. At the final 12 month visit the ECG sustained a 79% decrease in children's exposure to parents' second-hand smoke compared to a 34% decrease in the MCG and 42% in the CG. Pairwise comparisons showed the ECG decreased exposure significantly greater ($p<0.01$) than the MCG and CG. In terms of second-hand smoke exposure in the home from *all* smokers, the ECG sustained a 51% decrease compared to 18% decrease in the MCG and 15% in the CG at 12 months.

In a two year follow-up of this intervention, Wahlgren et al. (1997) reported no reduction in median second-hand smoke exposure levels among the ECG. The MCG reported a 66% reduction and the CG reported a 25% reduction. In the original study all families were given a debriefing pack and the CG was given results of the second-hand smoke exposure monitoring (Hovell et al, 1994). The debriefing pack contained materials that included local smoking cessation resources and information about asthma and second-hand smoke exposure. A 'How to' booklet that described how to implement the counselling intervention on their own as well as diaries to record second-hand smoke exposure was included. Families in the control groups (MCG/CG) were given more detailed instructions on the materials and informed that the procedures had been effective in the ECG and encouraged to implement them at home. Thus the authors concluded that the debriefing materials may have contributed to the reduction of children's exposure in these two groups. 21.4% subjects in the ECG maintained and reduced children's exposure to zero compared to 3.6% in the MG and 3.8% in the CG (this was achieved through quitting smoking) (Wahlgren et al., 1997). The authors suggested a multi-component intervention that includes behavioural counselling may be able to sustain long-term positive changes in second-hand smoke exposure for asthmatic children.

An education based intervention delivered to 1483 mothers of sick children in paediatric wards by trained paediatric nurses comprised standardised advice, booklets on preventing exposure and helping fathers quit, no-smoking stickers and a phone reminder one week later. The results showed the intervention group (IG) mothers adopted more controls to reduce their child's second-hand smoke exposure in the home at three months than control group (CG) mothers (IG 78.4% v CG 71.1%, $p=0.01$). However this was not sustained at 6 and 12 month follow-up suggesting that in this context any changes were only short-term (Chan and Lam, 2006).

Harm reduction, verbal feedback on children's urine cotinine/creatinine levels, and tailored advice were given to 292 low-income parents of asthmatic children in one US controlled trial (Wakefield et al, 2002). The IG received a letter with cotinine feedback, booklets on asthma and tips on reducing second-hand smoke exposure. They also received tailored feedback on reported levels of restrictions in the home and recommendations for further restrictions (or quitting if a ban was already in place). The index parent was contacted one week later to reinforce the advice given and to allow for further clarification or advice if needed. A final phone call was given at one month to provide additional advice and encouragement. Although the results were not statistically significant they did show some positive results with a relative increase of 19% among the IG for a ban on smoking in the home compared to a relative increase of 6% among the CG. In addition, the numbers reporting a

household ban on smoking in cars increased 33% in the IG compared to 29% in the CG. Daily cigarette consumption declined modestly in both groups but the group difference was not statistically significant.

The LET'S Manage Asthma randomised controlled trial (RCT) evaluated the effectiveness of an enhanced behaviourally-based, cotinine feedback and monitoring intervention to reduce second-hand smoke exposure, lower health care use and improve other health outcomes in 352 children with asthma aged 3 – 12 years (Wilson et al, 2011). Feedback on the urine cotinine test results was provided only to the IG parents. There was no statistical difference between the IG and CG in relation to a reduction in second-hand smoke exposure at 6 and 12 month follow-up as measured by urine cotinine nor was there a significant effect on asthma-related care utilisation. However, among children considered to have high-risk status[6] the intervention was associated with significantly lower urine cotinine measures than usual care. At follow-up, there was a trend toward greater odds of a home smoking ban for the IG, though this was not significant.

One recent environmental intervention tested the effects of high-efficiency, particulate arresting (HEPA) air cleaners on unscheduled asthma visits and symptoms among children with asthma that were exposed to second-hand smoke (Lanphear et al, 2011). Using a RCT design, the IG (n=110) received two active HEPA filters whilst the CG (n=115) received two inactive HEPA units. There were no attempts by the study team to reduce smoking in the home or reduce other asthma triggers. In both groups airborne particulate monitors were placed in the main activity room and the child's bedroom. There were 42 fewer unscheduled asthma visits among the IG (n=185) compared to the CG (n=227) (p=0.43), equivalent to a reduction of 18.5% in the number of unscheduled asthma visits during the study. There was a significant difference (p=0.26) in the reductions in airborne particles of >3μm in the IG (25%) compared to the CG (5%). There were no significant differences in parent-reported asthma symptoms, exhaled nitric-oxide levels, air nicotine levels, or cotinine levels according to group assignment.

Though not specifically targeted at asthmatic children, two studies aimed to encourage smoking cessation among parents of children attending hospital or out-patient clinics for general respiratory problems (Ralston and Roohi, 2008; Winickoff et al, 2003). Both studies used a mixture of counselling, advice provision and nicotine replacement therapy (NRT). Although the Ralston and Roohi study showed higher quit attempts in the IG (14%) than in the CG (5%), the sample was small (n42) with a low enrolment rate and high loss to follow-up. However 60% of the smoking parents did not believe their smoking was associated with their child's hospitalisation, although 91% believed their smoking was affecting their own health (Ralston and Roohi, 2008). The Winickoff et al (2003) study was more successful in achieving smoking cessation with a combination of approaches, including NRT provision. Their results showed that at a two month follow-up 56% of parents had made a quit attempt of more than 24 hours; 18% reported a seven day quit; 34% used NRT and 42% received additional counselling from a smoking quitline.

[6] High-risk status was considered if children had at least one asthma-related hospitalisation or emergency department visit, were dispensed >6 units of short actine beta-agonist medication, and/or were prescribed asthma medication by > 3 physicians.

Furthermore, the mean number of cigarettes smoked inside the home and car declined over two months (home 5.1 v 1.4; and car 2.5 v 1.4). Although, the study showed some positive results, no control group was included in this feasibility study. However both studies indicated that a child's attendance at a paediatric clinic might be an opportunity to provide parents with second-hand smoke awareness and advice.

Delivery settings

In terms of settings, the systematic reviews did not find one setting any more effective than another (Priest et al, 2008; Baxter, 2011). Among the papers examined here, 12 were based in the community setting and 11 were based in clinical settings, such as paediatric hospitals or child-health clinics.

Community-based interventions

In the community settings, all studies reported some level of effectiveness in reducing children's exposure to second-hand smoke in the home (Hovell et al, 2009; Abdullah, Mak and Loke, 2005; Emmons et al, 2001; Greenberg, Strecher and Bauman, 1994; Hovell et al, 2000; Lanphear et al, 2010; Sockrider, Hudman and Addy, 2003; Wakefield et al, 2002; Alwan et al, 2009; Liles et al, 2009; Hacker and Wigg, 2010; Wilson et al, 2012a) though two were not tested for statistical significance (Wakefield et al; Hacker and Wigg). These interventions used a mixture of biochemical feedback, indoor air quality measures (IAQM), counselling and information provision.

In one US RCT of 150 smoking mothers, the combined intervention included targeting second-hand smoke exposure reduction with a smoking cessation component tailored to each participant (Hovell et al, 2009). Treatment consisted of 10 in-person at home counselling sessions and four telephone counselling sessions over six months, with additional pre- and post-quit telephone sessions. Counselling procedures included behavioural contracting, self-monitoring and problem solving. The intervention effect (baseline to six months) showed a larger decrease in children's exposure to mothers' smoking in the home among IG (79.8%) compared to CG (54.9%); children's reported second-hand smoke exposure from all sources decreased 85.2% among IG compared to 57.3% among CG; mothers' smoking status decreased 34.4% among IG compared to 5.1% among CG. However, the maintenance effect (6-18 months) showed mothers' mean smoking increased 33.1% among the IG compared to 4.6% among the CG, suggesting the intervention was effective at least in the short-term, albeit not maintained longer-term (Hovell et al 2009). In a follow-up study, further analysis by Liles et al (2009) found that having quit for at least 24 hours in the year prior to baseline and the numbers of alternative cessation methods ever tried were predictive of the longest quit attempt during the 18 month study. Mothers in the IG who felt at baseline that second-hand smoke exposure posed a health risk for their children or who had more permissive home smoking policies had longer quit attempts.

In a large RCT carried out in Hong Kong of 952 smoking fathers and mothers of children aged 5 years, counsellors provided over the phone information on the health consequences of smoking, benefits of quitting smoking and hazards of second-hand smoke to smokers and their children; parents were also encouraged to

quit. Stage-matched self-help materials designed to target smokers at different stages of readiness to quit were further provided. A follow-up assessment and relapse prevention counselling was carried out at one and three months after first contact. At six months the self-reported seven day point prevalence quit rate was significantly higher in the IG (15.3%) compared to the CG (7.4%) ($p<0.001$). The authors calculated that the number needed to treat to get one additional smoker to quit was 13. Furthermore, complete home smoking restrictions at six months were higher in the IG (34.1%) compared to the CG (24.6%), as were partial restrictions of smoking at home (IG 62.7% v CG 56.4%) (Abdullah et al, 2005).

In a UK community intervention delivered over 6 months, a dedicated smoke-free home (SFH) team visited primary schools and used a SFH toolkit including activities with children aged 9 -11 (Alwan et al, 2009). Children were also given promise forms for parents to make a smoke-free homes pledge. The SFH team trained health professionals and other community workers to encourage their clients to impose smoking restrictions at home, and organised community based events and educational materials. 318 households surveyed found that total SFH increased from 35% at baseline to 68% at six month post intervention ($p<0.0001$). However when smoking households only were measured there was a small and non-significant increase from 41% – 48% (baseline to post-intervention). The study was not randomised and the findings were based on self-report (Alwan et al, 2009).

In Salford, England, local community members were trained and employed to deliver a SFH intervention to parents of young children, older people and people with respiratory problems (Hacker and Wigg, 2010). Participants were asked to sign up to a three-stage promise - gold, silver or bronze. Participants who made a promise were followed up after one month to assess whether they were ready or willing to upgrade their original promise. 3,261 promises were made with 47% from homes with at least one smoker. At follow-up 17% (n=63) of surveys were returned of which 51/63 (81%) reported making some change such as attempting to quit (14%); quit (25%); or cut down (42%). Just over two-thirds (68%) also reported changes in the behaviour of other adults in the house. While showing some positive results, including reportedly improved health for those with a respiratory condition, there was a low follow-up response rate and the findings were based on participants' self-report.

The REFRESH project was a randomised feasibility study that provided mothers with IAQM alongside motivational interviews in the home (Wilson et al, 2012a). A total of 59 smoking mothers with at least one child under the age of 6 years took part in the study. The intervention comprised four home visits over a 1-month period, which involved two 24 hour measurements of home air quality ($PM_{2.5}$) and a motivational interview to encourage changes to smoking behaviour within the home in order to reduce child second-hand smoke exposure. The enhanced group received their air quality data as part of their motivational interview at visit 2; the control group received their information at visit 4. The findings showed some promise in that while both groups experienced reductions in $PM_{2.5}$ concentrations, when testing paired samples for the enhanced group, there was a significant difference ($p<0.05$) between visit 2 and visit 4 values for maximum $PM_{2.5}$ ($p=0.006$) and for percentage of time over 35 $\mu g/m^3$ ($p=0.017$), with average $PM_{2.5}$

approaching significance (p=0.056). However, there was no significant difference for salivary cotinine measures. The qualitative findings showed that mothers understood the data they were shown and were shocked by the values measured in their homes despite being aware of the effects of second-hand smoke exposure. They also appreciated the intervention taking place in their homes as it allowed them to have data that was personalised to their own smoking behaviours. Many mothers described how they had changed their smoking behaviours, albeit incrementally, in their home and were motivated to protect their own children as a result of the knowledge they had gained. The authors conclude that providing mothers who smoke with personalised results about the indoor air quality of their homes along with a motivational interview is feasible and has an effect on improving household air quality (Wilson et al, 2012a).

There has been an increase in community based second-hand smoke interventions in the UK over the last decade although these often lack rigorous measures and evaluation, including lack of a control or comparison group. Self-report by parents and low follow-up response rates are major limitations of the studies examined here, but also equally across the grey literature, particularly in relation to the 'promise' or 'pledge' interventions.

It has been suggested that programmes to encourage smoke-free homes may need to be tailored to specific communities to achieve better results (Alwan et al, 2009; Lanumata et al, 2010). In order to achieve this, community surveys may provide insight into the types of interventions that can help engage and influence the target population (Alwan et al, 2009). A study by Bush et al (2003) of smoking in Bangladeshi and Pakistani communities in the UK used a community participatory approach in which members of the Bangladeshi and Pakistani communities participated in study development, implementation, and analysis in order to *inform* the development of effective and culturally acceptable smoking cessation interventions (the study did not test smoking cessation interventions). The authors concluded that gender, age, religion, and tradition had an important influence on smoking attitudes and behaviour, and that tradition, culture, and the family played an important role in nurturing and cultivating norms and values around smoking. (Bush et al., 2003).

Clinic-based interventions

In the clinical setting, eight of the 11 studies showed significant levels of effectiveness in terms of reducing children's exposure to second-hand smoke and/or parent quit rates (Arborelius and Bremberg, 2001; Chan and Lam, 2006; Groner et al, 2000; Hovell et al, 1994; Wilson et al, 2001; Wilson et al, 2011; Yilmaz et al, 2006; Zakarian, Hovell and Sandweiss, 2004). These interventions used a range and combination of approaches including behavioural counselling, motivational interviews, education, information provision and NRT.

The results of a RCT conducted in Turkey with 375 smoking mothers with children aged less than 16 years old and attending hospital for a healthcare visit for any primary complaint or well-child examination, found that mothers were more motivated by their child's health than their own (Yilmaz et al, 2006). Study participants were randomly assigned to either a smoking cessation intervention

aimed at children's health, their own health or a control group (CG). Information was provided to both intervention groups. The child intervention group (CIG) was given information on the risks of tobacco to child health. The maternal intervention group (MIG) was provided with information on the risks of tobacco to their own health. A written document on how to quit smoking was provided to both intervention groups. The CG received no advice other than general health information. The CIG had higher rates of cessation (24%) and smoking location change (73%) than the MIG (13% and 47% respectively) thus supporting the hypothesis that providing mothers with information on child health risks results in better outcomes than information on maternal risks alone.

However, an earlier study based in the USA which used a similar design produced different findings (Groner et al, 2000). The participants were given a brief (10 -15 minute) counselling session by a trained paediatric nurse. The CIG were informed of second-hand smoke exposure hazards on child health but not their own. The MIG were informed of smoking effects on their own health but were not given information about second-hand smoke exposure effects on children. In addition, the intervention groups were given a standard smoking cessation self-help manual and instructions on its use. The authors of the study found little effect on quit rates, with just 2% of participants reporting quitting smoking at 1 month follow-up and 4% at 6 month follow-up. While, not successful at encouraging cessation among the intervention groups and specifically the CIG, the intervention did result in a significant change in smoking location with 33% CIG ($p<0.5$) changing location compared to 14% MIG and 16% CG.

A longitudinal RCT undertaken in Finland with 1062 families of infants aged 5 months recruited from well-baby clinics found that similar to Chan and Lam (2006), outcomes were successful in the short rather than long-term (Kallio, Jokinen, and Hämäläinen 2006). Conducted over a nine-year period, the intervention infants were randomised to an intervention (IG) or control group (CG) at age 7 months. Families of the IG and CG met a paediatrician and dietician first at 1-3 month intervals and 4-6 month intervals respectively. After the age of two years the visits of both groups took place at six month intervals. When the CG reached seven years they visited research personnel once a year. The IG received individualised and targeted lifestyle counselling at each visit, which comprised mainly dietary counselling, with additional discussion on other cardiovascular risk factors, such as smoking. At age 5 years, the child's parents received a booklet about the adverse effects of smoking. If family history was positive for heart disease, the importance of quitting smoking was repeatedly discussed. The CG received regular health education material, given to all families at Finnish well-baby clinics. The results from this study showed a short-term effect with the proportion of smokers in both groups falling during the child's infancy and toddler years. The decline then slowed among fathers and stopped among mothers after the child reached 5 years. The smoking habits of parents in both the IG and CG did not differ (Kallio et al, 2006).

In terms of smoking cessation, another RCT that recruited 150 mothers of children aged less than five years from a well-child community clinic found that the evaluation of the intervention showed no long-term effects on smoking cessation (Zakarian et al, 2004). Mothers in the IG were offered seven counselling sessions

delivered over six months. Sessions 1, 3 and 7 took place at clinical sites, with the remainder by telephone. Counselling included behavioural contracting for reducing children's second-hand smoke exposure, problem solving and positive reinforcement for successes. Counsellors assisted mothers with short and long-term goals for shaping their and other household members behaviour. Mothers were asked to use pictorial charts to self-monitor second-hand smoke exposure and smoking for three day intervals between sessions. Second-hand smoke exposure from maternal smoking declined in both groups from baseline to six months ($p<0.001$) and remained level at 12 month follow-up (IG decreased 71% v CG 60% baseline to follow-up). The same pattern occurred for second-hand smoke exposure from all sources ($p<0.001$) (IG decreased 58.6% v CG 66.5% baseline to follow-up). However, in terms of cessation at 12 month follow-up, more CG (10.8%) achieved 7 day quit status compared to IG (2.6%) (Zakarian et al, 2004).

Theoretical approaches

In the 23 studies examined in this review, a range of theoretical approaches have been adopted, most of which have been clearly stated by the study authors. The most common approach used in the design of interventions has been counselling (Arborelius and Bremberg, 2001; Groner et al, 2000; Hovell et al, 1994; Wahlgren et al, 1997; Kallio et al, 2006; Ralston and Roohi, 2008; Wilson et al, 2011; Winickoff et al, 2003; Zakarian et al, 2004; Emmons et al, 2001; Hovell et al, 2000; Hovell et al, 2009; Liles et al, 2009; Wilson et al, 2012a/b). Other approaches have included education (Chan and Lam, 2006; Wilson et al, 2001; Yilmaz et al, 2005; Abdullah et al, 2005); goal setting (Greenberg et al, 1994; Alwan et al, 2010); community development (Hacker and Wigg, 2010); and biofeedback (Emmons et al, 2001; Wakefield et al, 2002). A number of the interventions have used a combination of these approaches.

Priest et al (2008) identified a small number of studies that reported greater efficacy with intensive counselling programmes within clinical settings, although they were unable to determine that one intervention reduced parental smoking more effectively than any others (Priest et al, 2008). Furthermore, the authors posit that while interventions appear relatively successful in changing participants' knowledge of the effects of second-hand smoke exposure, this may not necessarily result in sustained behaviour changes or reductions in children's exposure to second-hand smoke (Priest et al, 2008).

Of the 13 interventions examined in this review that employed a counselling approach, five were set in the community and eight in clinical settings. The community/home based settings all showed a statistically significant effect compared to 5/8 of the clinic based interventions; however these results should be viewed with caution due to small sample sizes, high rates of drop-out and lack of control group measures.

Based on the behavioural ecological model (BEM)[7] Hovell et al. (2009) hypothesised that the addition of smoking cessation services to second-hand smoke exposure interventions which include counselling, may offer motivation for parents to quit smoking and contribute to longer-term abstinence, than stand-alone second-hand smoke exposure interventions

Motivational interviewing combined with personal feedback on household nicotine levels has been used in Project KISS, a US RCT of 291 smoking mothers (Emmons et al, 2001). The motivational intervention (MI) group received a 30 – 45 minute MI counselling and goal-setting session in the home with four follow-up counselling phone calls and feedback on nicotine levels at baseline (as measured by passive sampling dosimetry). The self-help (SH) group were given written materials and feedback at final assessment. Follow-up assessments of both groups were collected at three and six months. There was a significant difference between the SH and MI groups in household nicotine levels at six months with the MI group levels significantly lower ($p<0.5$) than the SH group. By the six month assessment there were no significant changes in nicotine levels in the SH group, though concentrations were higher than at baseline. Overall, cessation rates of both groups were 7.5% and 10.1% at three and six months follow up respectively. There was no significant difference in cessation or smoking rates between groups (Emmons et al, 2001).

A feasibility study that employed MI techniques with the aim of increasing cessation rates among smoking mothers of children with respiratory problems showed some success in quit rates and reducing second-hand smoke exposure in the home and car however this was not a RCT and statistical significance could not be tested (Winickoff et al, 2003).

As noted previously the REFRSH study utilised motivational interview techniques together with air quality feedback. The motivational interviews followed a script in which mothers were given information on the risks of second-hand smoke to children and the importance of creating a smoke-free home after which the mothers were encouraged to identify the pros and cons of any current and future smoking restrictions in the home, as well as how to overcome difficulties they might face in changing their smoking behaviours in the home. The outcomes in the enhanced group varied post-intervention, with homes smoke-free, partially smoke-free or making no changes. Among those mothers who achieved partially smoke-free homes, the changes in home smoking behaviour were incremental; e.g. mothers restricted smoking to one room or stopped smoking in the car. While this particular cohort were unable to achieve a completely smoke-free home, the changes they made were beneficial to reducing second-hand smoke exposure and were related to the nature of the restrictions and personal circumstances in their homes pre-intervention. The REFRESH findings indicate that a process of incremental change is perhaps more realistic rather than trying to impose a final ideal outcome (smoke-free home). Valuing any change and acknowledging a mother's capability to achieve

[7] The BEM stresses the function of behaviour (e.g. consequences produced by the behaviour) and environmental influences on (i.e. consequences of) behaviour. In the context of second-hand smoke exposure, the BEM suggests that cultural values such as protecting children may act as a motivating force in smoking cessation, particularly during second-hand smoke reduction counselling.

change, however small, is empowering and an important element to incorporate into future smoke-free home interventions. (Wilson et al, 2012b).

The use of targeted and tailored advice, including goal-setting, has been shown to have some potential. Eleven studies specifically cited targeted advice and goal setting as part of the intervention design (Hovell et al, 1994; Kallio et al, 2006; Zakarian et al, 2004; Abdullah et al, 2005; Emmons et al, 2001; Hovell et al, 2000 Hovell et al, 2009; Liles et al, 2009; Alwan et al, 2010; Greenberg et al, 1994; Wakefield et al, 2002). All studies except Kallio et al and Wakefield et al reported significant reductions in children's reported second-hand smoke exposure in the home.

Further studies employing educational materials have shown some promise. One was aimed at non-smoking mothers with husbands who smoked (Chan and Lam, 2006). The primary aim was to encourage the mothers to take action to reduce the child's exposure to the fathers' second-hand smoke. The results showed a higher increase in positive action to reduce second-hand smoke exposure among the intervention group compared to the control group, however the difference was small and not significant at follow-up (Chan and Lam, 2006). As noted previously, Yilmaz et al (2005) reported promising results in relation to cessation and smoking location changes when materials on child health (and to a lesser degree maternal health) risks were provided to mothers. In another study, counsellors provided information on the health consequences of smoking, hazards of second-hand smoke, benefits of quitting smoking to smokers and their children, and encouraged smokers to quit. They further provided stage-matched self-help materials designed to target smokers at different stages of readiness to quit. The study showed positive results for seven day quit rates (Abdullah et al, 2005).

Wilson et al (2001) reported significant results in reducing asthma–related visits and hospitalisations with parents of 3-12 year old children seen for asthma. Three nurse-led sessions provided basic asthma education with a combination of behaviour changing strategies over five weeks with feedback on children's urinary cotinine levels. In addition to reducing asthma-related incidences, the IG also reported greater smoking restrictions in the home (Wilson et al, 2001).

A large RCT with 485 women enrolled at 28 weeks gestation with a history of smoking prior to pregnancy used a videotape and 5 newsletters delivered between 28 weeks gestation and 6 weeks postpartum to mothers (a different video was sent to partners) with the aim of reducing second-hand smoke exposure and encouraging cessation (Sockrider et al, 2003). The newsletter included specific messages about protecting infants from second-hand smoke exposure, a smoke-free home sign, and tips on relapse prevention. 63% of the IG had a home smoking policy in effect at three months postpartum, 60% at six months and 64% at 12 months. Rates of home smoking restrictions at six months post-partum were 82% among those who had quit smoking; 61% among those who had quit but relapsed; and 34% among those who did not quit at six months. When compared with controls, smokers who received the smoking intervention were significantly more likely to limit smoking in the home (58% and 29% allowed smoking in the home, respectively). The final model indicated that having a home smoking policy at three months predicted having a

policy at six months postpartum ($p<0.01$). Similar results were obtained when the same method was applied to 12 months postpartum data, using six months data to predict 12 month policy ($p<0.01$) (Sockrider et al, 2003).

Interventions have also included nicotine replacement therapy (NRT) as an aid to cessation (Winickoff et al, 2003; Ralston & Roohi, 2008; Hovell et al, 2009). In the three studies cited here, all intervention groups showed an increase in quit attempts. In one study, one-third of participants utilised NRT with 18% reporting a seven day quit rate at two month follow-up (Winickoff et al, 2003). In Hovell et al's study (2009), a larger proportion (66%) reported use of NRT ($p<0.001$) during the intervention period, and at six months the mothers' mean smoking rate had decreased 34% among the intervention group (IG) compared to 5% among controls. Ralston and Roohi (2008) did not report on the uptake of NRT among their study participants, although they did report that 14% of the IG had maintained smoking cessation at six month follow-up. This result, the authors suggested, compared well with the best-reported quit rate of 13.5% in an earlier paediatric-based smoking cessation intervention for low-income women. NRT has been proven to help smokers quit, although to what extent it is more effective in terms of helping mothers quit smoking or reducing second-hand smoke in the home is debatable and requires further study.

Legislation banning smoking in enclosed public spaces together with media support may enhance the impact of community-based and family interventions that work through schools and other venues in reducing second-hand smoke exposure in private settings. Such strategies may then help support practitioners in working with parents to reduce second-hand smoke exposure in the home (Botelho and Fiscella, 2005). In 1992 in Victoria Australia, a media campaign on passive smoking in the home was launched. The campaign urged smoking parents not to expose their children to tobacco smoke and encouraged parents to smoke outside and ban smoking in their homes. Evaluation of the campaign indicated a strong positive impact among non-smokers but less effect among smokers. Nevertheless, in households where at least one smoker lived and children were present, smoking restrictions on visitors to the home rose from 29% in 1992 to 53% in 1997. In houses where all adults smoked and children were present, these restrictions rose from 12% to 32% over the same time period (Borland et al, 1999). A four year media campaign launched in New South Wales Australia in 2002 targeted parents of young children living in more deprived areas (Crawford 2008). The campaign aimed to tap into parents' desire to protect their children and gave a clear message that smoking needed to be taken outside. The evaluation found a 58% increase in smoke-free homes within the target audience following the campaign.

The introduction of Scotland's 2006 smoke-free legislation[8] for public places has made some progress towards promoting health in children by reducing exposure to second-hand smoke in public spaces although less impact has been made on the higher levels of exposure in the home experienced by children whose mother or both parents smoke. Akhtar et al (2009) surveyed 2,527 primary school children one

[8] For further information on tobacco control legislation in Scotland go to http://ashscotland.org.uk/ash/4263.html

year after the implementation of Scotland's smoke-free legislation. The proportion of primary school children reporting a complete ban on smoking in their home, as opposed to a 'partial' or 'no ban', increased independent of parental smoking status, from 47% to 52%. However, children who reported living with smokers were less likely to have 'stringent restrictions' at home compared with children who lived with non-smoking parents (Akhtar et al, 2009). Furthermore 19% of children were found to be exposed to second-hand smoke at a level that has been shown to be harmful to arterial health (≥1.7 ng/ml) highlighting the fact that work must continue to help parents reduce second-hand smoke exposure in the home (Akhtar et al, 2007).

2.6.1 Summary and implications for research in the UK

Interventions aimed at reducing second-hand smoke exposure have shown some levels of effectiveness, although caution must be applied due to some of the limitations inherent in the studies, such as self-reported measures and lack of biofeedback to validate reported exposure levels. Nevertheless, the research suggested the most effective interventions have been those based on more intense contact with parents over a longer time-period, and those that utilise behavioural strategies (see Table 1). Moreover, parents with a pre-existing concern over second-hand smoke exposure and child health may be more motivated to change their smoking practices within the home, even if unable to quit smoking.

Certainly there are some fundamental differences in approach and delivery between the interventions reviewed, and the longer-term maintenance of any observed effect is an important area that requires further exploration and consideration when designing and measuring interventions to reduce children's exposure to second-hand smoke. Only three of the studies identified in this review provided follow-up data on the effects of the interventions beyond 12 months; 10 provided follow-up data at 12 months post intervention and eight at six months. Therefore future intervention designs should consider longitudinal measures in order to measure the short, medium and long-term impact of second-hand smoke interventions on smoking behaviours in the home.

In well-child populations the use of materials emphasising the effects of second-hand smoke exposure on children's health may be more effective than interventions that provide general second-hand smoke exposure health messages e.g. those relating to adult (or mother's) health rather than to children. The use of educational materials and tailored advice may provide parents of sick children with the knowledge and motivation to reduce second-hand smoke exposure in the home and reduce children's health-care utilisation, as may behavioural counselling within a multi-component intervention. However, it is unclear which component, of a multi-component intervention is most effective on outcome measures, thus making it difficult to ascertain what single aspect of an intervention, if any, may be most useful in reducing second-hand smoke exposure in the home. Nevertheless, interventions that use educational materials to reinforce the second-hand smoke message have shown some promising results, and it may be worth exploring further the utility of such materials when designing future interventions.

It is not clear from the papers examined what difference, if any, the delivery setting has on outcomes. Clinical settings show promise and offer a window of opportunity

for health workers to engage with parents and raise the issue of second-hand smoke exposure on child health, but to what extent the setting has a bearing on positive outcomes is not measured. Nevertheless, whether based in the clinic or community, behavioural counselling does show some effectiveness and there is also some evidence that targeting parents based on readiness to quit and previous quit attempts may be effective in reducing smoking and second-hand smoke exposure in the home. This may be particularly useful for smoking cessation practitioners who may be able to encourage parents that are unable to quit to at least change their smoking location away from the home.

The development of community based interventions should ensure the intervention meets the needs of the community it aims to help and interventions should consider the cultural and social norms within that community. Utilising local knowledge and community members may improve uptake and outcomes for these interventions. Current evaluations of community programmes that utilise pledge systems are not routinely objectively measured (e.g. cotinine or air quality measures) and are most often based on self-report. Consequently it is unclear how effective these pledge systems are. In order to ascertain whether one setting is more effective than another it would be useful to develop and conduct studies that measures interventions across different delivery settings.

Furthermore, media support, via campaigns may improve the outcomes of community-based interventions by raising the issue among the general population and help support professionals working with families to reduce smoking in the home.

In summary, there is no consensus in terms of approach, delivery or population as to the “best” method to reduce children’s exposure to second-hand smoke. Moreover, there is a relative paucity of data from the UK compared with the US, suggesting the need for further research in the UK to measure the effectiveness of smoke-free home interventions. Ideally future trials and studies would adopt robust methodologies, ideally using RCT designs with strict control group conditions and objective measures of success, such as air quality and cotinine measures. Qualitative data that explores the nature of smoking behaviour changes over the course of an intervention would add rich detail and may offer important insights into behaviour changes that can sometimes be lost in purely quantitative studies. Additionally, process evaluations may illuminate the acceptability and utility of the different components of complex interventions as experience by the target group and those who deliver the interventions. Future studies should also be carried out over longer periods of time to measure their effectiveness, as longer interventions appear to be more effective than short interventions and longitudinal studies have so far been few in number, particularly in the UK.

2.7 Professional views on smoke-free home interventions

There is limited research into professionals and policymakers' views on second-hand smoke exposure in the home and the implications and way forward for policies and interventions to reduce smoking in the home.

A recent qualitative study by Ritchie et al (2009) exploring the views of 'experts' in Scotland, with tobacco control and community development experience, identified that they were aware of the 'sensitivities' of the boundary between the 'private' home and public health interventions. The experts agreed that education on the harms caused by second-hand smoke exposure needs to be embedded in the wider general population. They also identified gaps in professionals' knowledge of the risks of second-hand smoke exposure in the home on children's health and effective interventions, such as whether to implement a stepped approach similar to the pledge programmes or whether to advocate a complete smoke-free homes approach. In addition it was noted that some professional health workers are reluctant to address the issue with parents for fear of damaging the client/worker relationship. They identified a need for suitable training and information on both second-hand smoke exposure and the development of appropriate attitudes and skills in order for professionals to work effectively with parents and carers who smoke. There was agreement that an up-to-date review of evidence should inform key messages and feed into existing and new initiatives, and that these messages are clear and consistent with coordination between national and local bodies. Policies around smoke-free homes should also be mindful of the environmental and socioeconomic circumstances of families in order to avoid disempowering or stigmatising parents. However this needs to be balanced with the rights of children to a healthy environment; in particular those children who are ill and susceptible to the risks of second-hand smoke exposure in the home and elsewhere (Ritchie et al, 2009). A study with Pacific policymakers identified a preference for a 'bottom-up' approach that incorporated community controlled activity with a focus on changing public attitudes to, and knowledge on, second-hand smoke through education rather than government regulation (Lanumata, Thomson and Wilson, 2010).

A focus group with 10 health professionals from Glasgow found that while they promote both stop smoking and second-hand smoke messages to parents, much depends on the circumstances and environment within the home. They were conscious to avoid telling people 'what to do' and felt their role was to give the best information possible and leave the clients to make their own choices regarding smoking in the home. However there was evidence of inconsistency in these messages. The authors recommended training across the range of health professionals to improve the consistency of second-hand smoke messages given to parents (XL Communications, 2009).

There are a number of studies that have explored medical professionals' attitudes to smoking. Surveys of nurses or community based-mental health workers have shown that professionals who smoke or are ex-smokers are less likely to provide optimal smoking cessation support to their clients. (Johnson et al, 2009; Jenkins and Ahijevych, 2003). Personal smoking behaviours may influence their beliefs about smoking and their views on providing support to help smokers quit (Lenz, 2008). In a

small study in a London hospital, 78 maternity staff were asked a series of attitudinal questions relating to smoking and pregnancy. The authors concluded that although the maternity staffs' reported attitudes were supportive of their role in smoking cessation, they did not translate into practice and the level of smoking cessation interventions was low, suggesting a gap between attitudes and behaviours. However they did find a positive association between smoking cessation training and attitudes, although the effect on their practice was small (Condliffe, McEwan and West, 2005).

General practice is an important area for screening, prevention and early intervention and while almost all GPs consider it part of their role to advise and assist patients to stop smoking, only half of GPs routinely advise smokers to stop (McEwan, West and Preston, 2006).

The barriers to tobacco control practice are in part a function of professionals' perceptions about damaging their relationships with clients if they raise the issue of smoking. This concurs with research among GPs who were concerned with harming their relationship with patients if they discussed smoking behaviours (MacIntosh & Coleman, 2006). More recent work by Stuber & Galea (2009) suggested that smokers often do not disclose their smoking status to their health practitioners.

US studies have demonstrated that paediatricians and family physicians lack confidence in addressing parents smoking behaviours, even where children present with second-hand smoke related illnesses (Perez-Stable et al, 2001; Tanski et al, 2003). Further barriers to address smoking behaviour changes with parents included lack of time, and knowledge about environmental tobacco smoke (Collins, Levant & Bryant-Stephens, 2007). Research that explores the perceptions and practice of paediatricians in the UK would help identify the barriers and opportunities for second-hand smoke interventions among this vitally important body of professionals.

While second-hand smoke intervention training is recommended to foster confidence in raising the issue and enhance their intervention skills (Perez Stable et al; Collins et al), a recent evaluation of professional brief intervention training delivered in Glasgow to reduce second-hand smoke exposure in the home recommended targeting training to those who are best-placed to support parents to make smoking behaviour changes in the home (Gordon, Friel & Granachan, 2012). The authors suggest that any decisions on who to target for training needs to be informed by the context in which professionals work, and the opportunities and barriers within these. While they propose that those working in health-visiting teams are best placed to carry forward second-hand smoke messages and provide sustained support to families, they also advocate clear and consistent evidence-based second-hand smoke messages across all disciplines working with families and children (Gordon et al).

In a randomised controlled trial of a GP desktop resource (GDR: a smoking cessation intervention tool) the research showed that concern over the doctor-patient relationship was an independent predictor of the number of patients advised to stop smoking. The GDR worked by reducing the concerns GPs had over providing patients with anti-smoking advice (McEwan, West and Preston, 2006). A US study of midwives also found that increased rates of tobacco treatment practice

were achieved when an office based system that provided cessation materials and resources was available to staff (Abatemarco, Steinberg and Delnevo, 2007).

The implications for practice suggest that intervention tools that are readily available to health professionals and GPs could possibly be an effective resource in helping encourage smokers' quit attempts. Furthermore smoking cessation training that bolsters the confidence of professionals to engage potential smokers may help increase the smoking cessation rates of parents and carers thereby decreasing children's exposure to second-hand smoke.

A report from a Glasgow smoke-free homes intervention (based on a pledge system) identified a number of barriers regarding uptake of the intervention. The initial route chosen was to recruit parents of asthmatic children into the intervention via nursery and primary schools. Reflecting on the work undertaken, the coordinator reported some resistance amongst the head teachers. Concerns were raised about 'singling out' children who were inhaler users; others thought it was not the responsibility of the school to provide information on smoking behaviour in the home as it might jeopardise existing relationships with parents; and concerns were raised about the time and effort required from schools to promote the project. Health professionals were also resistant to the pledge system as there is no evidence to show that restricting smoking to one room protects children from the effects of second-hand smoke (Cornwall, 2007).

2.7.1 Summary

There is very little national or international literature on professionals' views on smoke-free home interventions. This review has identified gaps in a range of professionals' knowledge of the risks of second-hand smoke exposure on children's health, and inconsistency in the advice and information given to parents and carers. It is estimated that less than half of GPs routinely advise smokers to stop. Furthermore many of those working in the field, including GPs, may be reluctant to raise the issue of smoking in the home with parents in case this has a negative impact on their relationships with parents. Some research has shown that the provision of intervention tools that are readily available could be an effective resource for health professionals. Training on the effects of second-hand smoke exposure on children's health is required across a range of professions who are in contact with families and children. Training that is consistent would improve the advice and information that is relayed to parents and carers. In addition further research is required in order to better understand professionals' views on second-hand smoke exposure and the barriers they experience or anticipate when raising the issue with families. The links between the culture of professional practice and the nature of the professional relationship with clients, vis-à-vis the stigmatisation of health behaviour, requires further exploration.

2.8 Smoking and stigma

While de-normalising smoking behaviours has led to some public health benefits, research suggests that the stigmatisation of those who continue to smoke, coupled with the spatial segregation of socio-economically disadvantaged populations, may compound to produce 'smoking islands' that may serve to reinforce rather than discourage continued smoking (Thompson, Pearce and Barnet, 2007). Nevertheless, it has been argued that there may be circumstances where it is morally defensible to stigmatise certain health behaviours that pose a public health threat to the wider community (Bayer, 2008).

Bell et al (2010) argue that stigmatising smokers will in the end, not help to reduce smoking prevalence among poorer smokers but will exacerbate health-related inequalities by limiting smokers' access to health services. This is particularly important in relation to children with smoking parents from poorer backgrounds as therein lies the potential for further inequalities, not only in relation to their parents' health but also to their own. Therefore practitioners need cultural sensitivity to avoid stigmatising parents so that they can interact with parents in more refined ways and assist them in their decision-making processes (Botelho and Fiscella, 2005).

While there is evidence to suggest that smoke-free legislation does not increase smoking in the home (Fong, 2006; Akhtar, 2007; Edwards et al, 2008; Holliday, Moore and Moore, 2009; Callinan et al, 2010) it is acknowledged that smoke-free legislation may have contributed to feelings of stigma when smoking in public, therefore the freedom to smoke in one's own home may be viewed as increasingly

important to smokers (Phillips et al, 2007). As such there may be some resistance to externally imposed restraints on individual and private behaviours (Phillips et al). A longitudinal qualitative study in Scotland, pre and post smoke-free legislation showed that participants perceived the legislation to have increased the stigmatisation of smoking. Smokers reported feeling a loss of social status while smoking in public. While conceding the legislation was of public benefit they also engaged in self-stigmatisation and self-labelling of their own smoking behaviours, and stigmatised other 'less considerate' smokers (Ritchie, Amos and Martin, 2010).

While Ritchie et al's study found little differences in perceived stigma between high and low socio-economic groups of smokers, there is some evidence that different socio-economic groups understand, respond to and reflect on smoking bans in public places differently (Stuber, Galea and Link, 2008; Frohlich et al, 2010). For example, higher socio-economic groups are more likely to positively respond and adapt to tobacco control messages whilst lower socio-economic groups are more opposed to these messages and less open to the effects that tobacco control policies and interventions have on their smoking (Frohlich et al, 2010). Frohlich et al suggest the lower uptake of smoking cessation among lower income groups may be due in part to a mismatch between the often middle-class professionals delivering tobacco control and the increasingly 'marginalised' low income smoker. The authors recommend including active participation of the targeted groups, which may help to diminish the inequalities and 'alienation' that is felt by many lower socio-economic smokers. This may be particularly relevant to policymakers and planners when developing smoke-free home interventions, particularly those that are targeted in areas characterised by social and economic deprivation. In addition, the experiential knowledge practitioners have of the potential barriers for smokers who live in particular social contexts, should be recognised, valued and included in the 'evidence' that informs the development of interventions (Ritchie, 2012).

The picture in Scotland however is somewhat different from Frohlich's analysis. An analysis of data from the 2009 NHS Smoking Cessation Service Statistics (SCSS) shows a higher proportion of quit attempts to be in the most deprived categories and a smaller proportion in the least deprived. An earlier analysis of the 2007 SCSS data concluded that Cessation services in Scotland appear to be successful in reaching deprived communities at a national and local level. The percentages of all smokers quit at one-month in the most deprived areas were double those in the least deprived areas (1.5% compared to 0.7%) (Heeley, 2008).

Despite changes in the acceptability of smoking in the general population, economically disadvantaged smokers continue to live in communities where smoking remains highly visible and culturally normative (Ritchie 2012). The rate of smoking in disadvantaged communities in 2010 was 44% in the 10% of the most deprived communities, compared to 9% in the 10% of the least deprived communities in Scotland (Scottish Government, 2011). Inequalities in health are evident in these smoking rates. The high rates of smoking in the disadvantaged communities suggest that there is a continuing social acceptance of smoking and

that the impact of social de-normalisation has been more limited in disadvantaged communities (Ritchie, 2012). Research by Robinson et al (2010) has shown that women smokers in disadvantaged communities have more restricted social lives that are mostly home-based, and they are therefore less exposed to the newly created smoke-free environments in public places (Robinson et al, 2010).

Poland et al (2006) argued for further understanding of the social context for socially and economically marginalised groups. They stated that the social meaning of smoking in the context of people's everyday lives was not often a central concern in tobacco control research (Poland et al., 2006). Chapman & Freeman (2007) and Bell et al (2010a,b) argued for qualitative research to contribute to an understanding of the lived experience of smokers of the social de-normalisation of smoking. Whilst understanding of the social context is not new in tobacco control, it may be a missing element in addressing tobacco control in disadvantaged communities (Ritchie, 2012). The stigmatisation of smokers, and in particular disadvantaged smokers, needs further consideration in relation to their socio-economic and environmental stressors, and their ability to sustain quit attempts and change smoking cultures in public places and the home (Ritchie, 2012).

Hilary Graham (2012) has recently discussed how the stigmatisation of smoking has occurred 'against a backdrop of widening socioeconomic differentials in smoking and the increasing importance of the body and behaviour in public discourse about social class and moral worth.' Graham contends that social class is an important 'analytic lens' through which the stigma of smoking and stigmatising impacts of tobacco control policies can be understood (Graham, 2012) Graham describes how class inequalities have underpinned the rise and fall of smoking prevalence and the emergence of smoking as a signifier of class and stigmatised identity. She argues that tobacco control policies should engage directly with social inequalities. While current policies are directed at changing smoking behaviours they do not attempt to address the inequalities in life chances and living standards that leave the most socioeconomically disadvantaged at greater risk of smoking. Therefore tobacco control policies risk ignoring the structural conditions that underlie not only smoking and stigma but also the wider inequalities of which smoking is a part (Graham, 2012)

A qualitative narrative review of perceived discrimination and stigma literature was conducted by Burgess et al (2009) to explore the potential consequences of tobacco control policies designed to reduce children's exposure to second-hand smoke on socially disadvantaged mothers who smoke. They found evidence that strategies designed to reduce second-hand smoke have contributed to smoking stigmatisation that may have unintended outcomes for socially disadvantaged mothers who smoke such as decreased mental health; increased cigarette use; avoidance or delay in seeking medical care; and poor treatment by health professionals. The authors posit that socially disadvantaged women have less leisure time, social support, access to smoke-free environments and more household responsibilities than their

more advantaged counterparts. Furthermore because low-income women have higher levels of chronic stressors, the additional stress of quitting cigarettes may be more difficult to manage. This lack of resources is likely to increase the difficulty of quitting and maintaining a smoke-free home and may also add to feelings of low self-efficacy and control. They may also have fewer alternative means of pleasure and stress reduction with which to replace smoking. They suggest tobacco control initiatives should focus on 'parents' and not single out mothers who smoke. Moreover, second-hand smoke messages should utilise a 'challenge' rather than 'stigma' format. A challenge format would focus on the health concerns of second-hand smoke exposure and promote social inclusion, optimism and hope. A challenge format could show a community event honouring parents who have successfully quit or feature children talking about how proud they are that their parents have quit. In contrast a stigma format contains messages that depict the person (i.e. the smoking mother) rather than the health condition (smoking status) as the problem. This format has the potential to activate feelings of shame, disgust and blame toward the smoker and promote social exclusion and discrimination of the smoker (Burgess, Fu and van Ryn, 2009).

'De-normalising' and stigmatising smokers may have the undesired effect of increasing certain groups' 'resistance' to smoking cessation messages (Bayer, 2008). For example, Farrimond and Joffe (2006) found that while lower socio-economic smokers may internalise the stigmatised aspersions, the higher socio-economic smokers tend to challenge the facts on which the stigmatising is based. They argue that current health promotion campaigns that focus on the danger to others that smoking represents may fail to engage, in particular, those from the lower socio-economic groups (often already stigmatised for being poor, working class, unhealthy, single mothers) and thus perpetuate rather than remove smoking and health inequalities (Farrimond and Joffe, 2006).

The construction of smoking as a voluntary behaviour, messages that blame the smoker for harming others, structural forms of discrimination, and condemnation of smoking behaviour by family and friends all contribute to smoker-related stigma. That the effects of smoking are experienced differently across different socio-economic and racial/ethnic groups highlights the need to understand more fully stigmatisation and its role within tobacco control policies and campaigns (Stuber, Galea and Link, 2008).

2.8.1 Summary

The effectiveness of tobacco-related public health messages may be diluted by the unintentional stigmatisation of smoking behaviours. As observed, smoking is more prevalent in low income groups and the danger is that stigmatising smokers will exacerbate existing health-related inequalities by limiting their (and perhaps their children's) access to health services. Some have argued that smoke-free legislation may have contributed to feelings of stigma when smoking in public yet there is little

evidence to suggest that such legislation has contributed to increased smoking in the home. However due to the clustering of socio-economic groups in particular geographical areas, some researchers have argued that stigmatising smokers could lead to ‘smoking islands’ which may reinforce rather than discourage smoking.

There is some evidence that different socio-economic groups understand, respond to and reflect on smoking bans in public places differently. For example it has been hypothesised that the lower uptake of smoking cessation among lower income groups may be due in part to a disparity between the ‘middle-class’ professionals delivering tobacco control initiatives and the ‘marginalised’ low income smoker. One solution might be to include the targeted groups in the delivery of interventions which may help raise the participation of low income smokers.

In the context of smoke-free homes interventions some have argued that such strategies may have unintentional outcomes for socially disadvantaged mothers. Socially disadvantaged women have higher levels of stress and quitting cigarettes may be more difficult to manage among this group. Interventions that aim to reduce smoking in the home could focus on ‘parents’ and not single out mothers who smoke. Moreover, second-hand smoke messages should focus on the health concerns of second-hand smoke exposure and promote social inclusion, optimism and hope.

It is important that stigma and smoking is better understood in order that initiatives that aim to reduce children’s exposure to second-hand smoke can build on smokers’ sense of self-efficacy and control rather than contribute to further perceptions of stigma by already marginalised groups.

3. Research Limitations and Implications for Practice

A number of gaps have been found while exploring the literature on children's exposure to second-hand smoke in the home. Some of these have been identified in the research papers reviewed and others identified by the author of this review. The review has also provided scope to identify current and future implications for practice in reducing children's exposure to second hand smoke.

3.1 Research Limitations

There are a number of limitations and gaps in the research on second-hand smoke exposure. Many of the studies utilise self-reporting by smokers which may underestimate the prevalence of smoking in the home and in the presence of children. Given the potential for bias in parental reports of children's second-hand smoke exposure, future studies should where feasible, use biochemical verification of children's exposure to or absorption of second-hand smoke. There is also a potential for selection bias in many of the studies reviewed as people with higher levels of active and passive smoking may not take part in studies. Therefore studies with larger sample sizes that include a range of smokers are also recommended in order to adequately explore the effects of interventions of family and carer interventions to reduce children's exposure to second-hand smoke exposure (Priest et al, 2008).

A significant gap in the literature is that of the children's experience. None of the papers reviewed here included the children's views; this is an area that requires further investigation to assess how children experience second-hand smoke exposure in the home. Alongside the absence of the child's voice is that of the father. Many of the studies that have been reviewed here have concentrated on the experiences of mothers and it is important that the father's voice is also heard and understood. For example further investigation of partner's smoking during pregnancy is needed to help develop interventions that encourage them to engage in cessation and support tobacco control initiatives in the home (Bottorff, 2006).

There are also clear differences between various cultural groups in relation to their use of tobacco and within the UK literature on smoking in the home this is an area that is currently under researched. Detailed understanding of attitudes, beliefs, values, and behaviours in relation to smoking in minority ethnic groups is lacking. Such understanding is necessary to inform development of smoking cessation strategies that are culturally appropriate for these communities (Bush et al, 2003).

Thomson (2006) has argued that there is a general lack of studies that investigate the links between population level interventions and the prevalence of second-hand smoke exposure while a lack of attention has also been given to the significance of the home as the place where health-related activity takes place. Robinson and Kirkcaldy (2007a) also suggest that too many assumptions are made about what parents are actually prepared to do to reduce second-hand smoke exposure in the home therefore more research is needed to fully understand the home setting of parents. Importantly research is required to better understand relationship dynamics

within the home and how people negotiate smoking restrictions within the family and social circle. Such qualitative research would help increase understanding of the motivating factors and barriers that can help or hinder behaviour changes among parents and carers to make their homes smoke-free. In order to encourage a reduction in second-hand smoke exposure it will require an understanding of the role of comfort, pleasure and social factors, and the need to provide social support for people who rely on smoking to get through what may be relatively difficult lives (Hill, 2003). Copeland (2003) has argued that further research is required to explore the help smokers actually want and who might best deliver it (from the smokers' point of view).

A further significant gap in the research is an understanding of professionals' views on second-hand smoke exposure and the barriers they experience or anticipate when raising the issue with families. Further studies should explore professional's attitudes, knowledge and understanding of second-hand smoke exposure and its effects on children's health.

3.2 Implications for Practice

There is currently insufficient evidence to recommend one strategy over another to reduce the prevalence or level of children's exposure to second-hand smoke. Furthermore there is no clear evidence of success within different settings, including 'well child', ill child and community contexts. Priest et al (2008) in their review of interventions found that there was limited support for more intensive counselling interventions delivered to parents but greater support for interventions concentrating primarily on changing participants' attitudes and behaviours, rather than on changes in knowledge. It has also been suggested that motivational counselling on the effects of second-hand smoke exposure on child health may work more effectively with parents who have a pre-existing concern for the effects of second hand smoke on child health.

The NICE report (Taylor, 2005) made a number of recommendations for practice. These included a modification of social norms, to reinforce the elimination of children's second-hand smoke exposure. To achieve this further research and careful planning by a range of public health and policy makers will be needed, as well as intensive interventions that target the social context of smoking and other psychosocial issues. The report also recommends initiatives such as the introduction of home smoking bans. As noted previously, such initiatives have been legislated in other countries such as parts of Canada and the USA. The authors point out that as a public health effort, regulatory initiatives are more widely distributed and reach larger proportions of children who are at risk than individual clinical interventions. However to achieve a successful widespread increase in home smoking bans it is essential that initiatives are systematically evaluated to ensure effective implementation. In addition community education interventions could help reduce smoking in the home as well as the provision of self-help materials delivered in novel methods such as interactive computer programmes or videos.

Within clinical settings it has been suggested that paediatric healthcare should highlight parental smoking as an issue given that exposure to second-hand smoke is a significant cause of acute and chronic disease morbidity among children. In

addition, it should promote further the importance of postnatal second-hand smoke interventions that are integrated with and build on antenatal cessation interventions and investigate the effectiveness of nurse-delivered cessation treatment while also implementing a second hand smoke reduction protocol in the home. Health workers could also use parent and child visits to the healthcare clinic as an opportunity to discuss cessation and restructuring of the home environment to reduce second-hand smoke exposure within the home. A further suggestion is to incorporate a second-hand smoke exposure assessment as part of every well-child visit. And finally, investigate the development and evaluation of stepped-care approaches that are based on reliable behaviour modification principles, deploying strategies such as skills training, goal setting, problem solving, social support, and appropriate feedback and reinforcement, and the repeated delivery of second hand smoke advice within medical settings (Taylor, 2005).

4. Conclusion

In conclusion, smoke-free legislation in the UK and abroad has made an important contribution to reducing second-hand smoke exposure among the public generally. Improvements have been documented in respiratory health and coronary disease. Smoke-free legislation has also contributed to a decrease in smoking in the home, with parents and carers more likely to attempt indoor smoking restrictions. Research has identified that children from disadvantaged areas are more likely to be exposed to second-hand smoke in the home than children from more advantaged areas. While media campaigns on smoking in the home may have a positive impact on levels of exposure, research suggests this is stronger among non-smokers.

Smoking behaviours are influenced by the interaction of a number of physiological, cultural and environmental factors which can help promote or resist smoking. Professionals need to have an understanding of these factors as they can act as barriers or incentives for smoking in the home. In relation to smoking restrictions in the home, parents willing to change may need to negotiate any changes and this may be difficult for some parents to enforce. Despite health messages on the effects of active and passive smoking, there still remains a lack of knowledge or acceptance of these messages among some parents. Influenced by their own observations of their own or other people's children they may choose to ignore these messages. Therefore, interventions aimed at reducing smoking in the home should take into account the social, economic and environmental circumstances of parents and carers.

The effects of second-hand smoke exposure on fetal and child health are varied. It is now undisputed that smoking during pregnancy can increase the risk of a range of health conditions: miscarriage, pre-term delivery and low birth weight are all associated with maternal smoking and to a lesser degree passive smoking by the mother.

Children and infants inhale and ingest higher levels of second-hand smoke exposure in the home than adults. Estimates suggest that even where smoking in front of the child is restricted, the child's exposure to the toxins in second-hand smoke is still 5 to 10 times greater than a child from a non-smoking household. Where no restrictions are put in place, the exposure is greater still. Exposure to second-hand smoke in childhood is associated with a range of illnesses including reduced lung function, middle ear disease, a higher incidence of respiratory tract infections and Sudden Infant Death Syndrome. Furthermore second-hand smoke can trigger asthma symptoms among children affected and recent research has suggested a strong association between second-hand smoke exposure and long-term negative vascular health.

Although studies have shown an awareness of the general consequences of second-hand smoke exposure some parents' knowledge of the specific illnesses is still relatively poor. Interventions aimed at reducing second-hand smoke exposure have been shown to be effective although some caution must apply due to some of the limitations in the studies. Nevertheless the research suggests the most effective interventions have been those that are based on longer and more intense contact

with parents. There is a general consensus in the literature that any interventions need to take into account a number of moderating factors, including parents' pre-existing knowledge of second-hand smoke exposure on child health and smoking behaviours in the home. Furthermore in a multi-cultural society, a one-size fits all approach may not be effective in all communities therefore programmes to encourage smoke-free homes may need to be tailored to specific communities in order to achieve positive outcomes.

Some authors have argued that smoke-free legislation has contributed to feelings of stigma especially when smoking in public. Therefore the ability to smoke in one's own home may be viewed as increasingly important to smokers. There is some concern that stigmatising smokers will exacerbate existing health-related inequalities by limiting smokers' access to health services – they may feel disinclined to engage with health workers, including GPs, who they may perceive to be unsympathetic and judgemental of their smoking. This may be particularly true of smokers from low socio-economic groups who may already feel marginalised through factors such as unemployment, poor housing and single parenthood. Due to the clustering of socio-economic groups in particular geographical areas, some researchers have argued that stigmatising smokers could lead to 'smoking islands' which may reinforce rather than discourage smoking.

There is some evidence that different socio-economic groups respond differently to tobacco-control messages. For example it has been hypothesised that the lower uptake of smoking cessation among lower income groups may be due in part to a disparity between the 'middle-class' professionals delivering tobacco control initiatives and the 'marginalised' low income smoker. One solution might be to include the targeted groups in the delivery of interventions. This may increase the participation of low income smokers.

In the context of smoke-free homes interventions some have argued that such strategies may have unintentional outcomes for socially disadvantaged mothers. Socially disadvantaged women have higher levels of stress and quitting cigarettes may be more difficult for this group. Interventions that aim to reduce smoking in the home should focus on 'parents' and not single out mothers who smoke. Moreover, second-hand smoke messages should focus on the health concerns of second-hand smoke exposure and promote social inclusion and optimism rather than simply focusing on the harms caused to others. It is also vital that further interventions and public health messages do not stigmatise smokers.

There is a significant gap in the literature regarding professionals' views on smoke-free home interventions. Among the few papers explored here, this review has identified gaps in professionals' knowledge of the risks of second-hand smoke exposure on children's health and inconsistent advice and information for parents and carers. It is estimated that less than half of GPs routinely advise smokers to stop. However it has been suggested that many professionals working with families may be reluctant to raise the issue of smoking in the home with parents in case this has a negative impact on their relationships. Intervention tools that are readily available to health professionals in the clinical setting may provide an effective resource for raising the issue of second hand smoke in the home.

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Table 1. Details of intervention studies

Abbreviations: ***SHS = second-hand smoke; SHSE = Second-hand smoke exposure; RCT = Randomised controlled trial; IG = Intervention group; SFH = Smoke-free home; HEPA = High-efficiency particulate arresting; MI = Motivational intervention; RFS = Randomised feasibility study***

Study (author/date/country)	Design & sample	Intervention (& Setting)	Outcome measures	Results
Abdullah et al (2005) Hong Kong	RCT N= 952 Smoking fathers and mothers of children aged 5 yrs.	IG received 20-30 min of counselling over the phone. Counsellor provided information on the health consequences of smoking, benefits of quitting smoking to smokers and their children; and hazards of SHS and encouraged smokers to quit. Stage-matched self-help materials also provided (designed to target smokers at different stages of readiness to quit). CG received stage-matched self-help materials only. Follow-up assessment and relapse prevention counselling at 1 & 3 months after first contact. At 6 months both IG and CG followed up for final assessment (Home)	Self-reported 7 day point prevalence smoking cessation rate at 6 months with biochemical validation; 24 hr. point prevalence quit rate at 6 months without validation; continuous 6 month quit rate; implementation of complete smoking restriction at home; implementation of partial smoking restriction at home.	Self-reported 7 day point prevalence smoking cessation rate was significantly higher in the IG (15.3%) compared to CG (7.4%) (P<0.001). Biochemically validated quit rate (IG 10.6% v CG 4.5%). self-reported 24 hr. point prevalence quit rate - IG 17.3% v CG 8.7%; self-reported continuous 6 months quit rate - IG 4.1% v CG 2.7; complete restriction of smoking at home - IG 34.1% v CG 24.6%; partial restriction of smoking at home - IG 62.7% v CG 56.4%.

Alwan et al (2010) UK	Evaluation N=318 Households with at least one child in house surveyed at baseline (173 smokers) / 217 surveyed at post intervention (105 smokers)	Delivered over 6 months the SFH team visited primary schools and used a SFH toolkit including activities with children aged 9 -11; children were also given promise forms for parents to make a smoke-free homes pledge. The SFH team trained health professionals and other community workers to encourage their clients to impose smoking restrictions at home; and organised community based events and educational materials (Community).	difference in the proportion of households applying total smoke bans inside the home pre- and post-implementation of the intervention	Total SFH increased from 35% at baseline to 68% 6 month post intervention (sig @ P<0.0001). However this was not significant when smoking households only were measured with an increase from 41% – 48% baseline to post-intervention.
Arborelius and Bremberg (2001) Sweden	Surveillance-evaluation study - 28 families	Intervention based on self-efficacy. Discussions took place at normal health care visits and included knowledge of passive smoking and discussion of charting SHS exposure. At first follow-up, discussion on current smoking habits and suggested changes. At second follow-up, support habit changes and discuss problems (child health centres).	Parental smoking rate.	The rate of parental smoking was significantly lower in the years covered by the intervention (1997-99) compared with the preceding years (1994-96) (P<0.001 to P<0.008:chi-square test)
Chan and Lam (2006) Hong Kong	RCT - N=1483 non-smoking mothers of sick children with smoking husband	Educational intervention comprising standardised advice, booklets on preventing exposure and helping fathers quit, no-smoking sticker and phone reminder 1 week later (clinic)	Mothers take action to reduce child's SHSE produced by father.	At 3 months significantly more IG mothers took action than controls (78.4% v 71.1%, P=0.01) but this was not significant at 6 and 12 months suggesting the intervention was effective in short-term but not long-term.

Emmons et al (2001) USA	RCT N=291 current smokers/recent quitters with child ≤ 3 yrs.	Motivational intervention group (MIG) received 30 – 45 minute MI counselling and goal-setting session in the home with four follow-up counselling phone calls and biofeedback on nicotine levels at baseline. Self-help group (SHG) given written materials and biofeedback at final assessment. Follow-up assessments both groups at 3 and 6 months (Home).	household nicotine levels; smoking cessation	No significant difference between SHG and MIG in household nicotine levels at baseline but significant diff at 6 months with MIG significantly lower (P<0.5). No significant changes in nicotine levels in the SHG by 6 month assessment though concentrations were higher than at baseline. Overall cessation rates were 7.5% and 10.1% at 3 & 6 months follow up. No significant difference in cessation or smoking rates between groups.

Greenberg et al (1994) USA	RCT N=933 Smoking and non-smoking mothers. Eligible infants had to weigh at least 2000g at birth and be free of significant postnatal medical problems.	Four public health nurse visits of 45 minute duration to help parents develop skills to maintain a SFH. At visit 1 when infant approx. 3 weeks old nurse used a booklet to describe passive smoking, its health effects and identify sources of SHSE. Mother identified SHS sources that baby may be exposed to and mother set goals to reduce SHSE before next visit. Materials such as SFH stickers also provided which enabled mother to request smoke free environment without directly asking someone not to smoke around the baby. At visit 2 one month later goals re-evaluated assessed and modified if required. Visits 3 & 4 @ 2 month intervals as above. Plus positive reinforcement. Quitting smoking only discussed if raised by the mother (Home).	Number of cigarettes smoked per day in infant's presence; urinary cotinine; incidence of acute lower respiratory illness (ALRI) before 1 year old and persistent (PLRI) at 1 year.	Proportion of infants exposed to smoke increased in both groups over one year (IG from 33%-49%; CG from 34%-54%) but amount of exposure (number of cigarettes) in IG reduced 38% compared to increase of 7.5% in CG (equates to comparatively 5.9 fewer cigarettes per day at 12 months). Urinary cotinine increased in both groups (from 52%-79% in IG; 50%-86% in CG). No difference in ALRI between groups. Prevalence of PLRI lower in IG (17.8%) than CG (30.9%).

Groner et al (2000) USA	RCT N=479 female caregivers (16yrs and over) who accompanied a child <12 years to primary care centre of children's hospital for health care visit.	Brief (10-15minute) counselling session by trained paediatric nurse. Child health group (CHG) informed of SHS exposure hazards on child health but not their own; Maternal health group (MHG) informed of smoking effects on their own health but not given info about SHS exposure effects on children. Intervention groups given standard smoking cessation self-help manual and instructions on use. Also given group-specific handouts. Reminder postcards at 2 weeks and 4 month post-intervention. Contact by phone at 1 and 6 months for follow-up (clinic).	smoking status with abstinence defined as no cigarettes in previous week; stage of change; changes in smoking location; ETS knowledge	No significant effect on quit rates at follow-up points; no significant effect on stage of change at follow-up points; CHG subjects showed significant change in location at 6 month follow-up (P<0.5) with 33% changing location compared to 14% MHG & 16% control group; ETS knowledge increased significantly in CHG from 64% items correct at baseline to 69% at follow-up points.
Hacker and Wigg (2010) UK	Evaluation. Parents of young children, older people and people with respiratory problems	3 stage promise 'gold, silver, bronze'. People who made a promise followed up after one month to assess whether ready/willing to upgrade promise. Seven local residents recruited to act as Smoke-Free advisors and trained and encouraged to engage with communities that were appropriate to the area. Individuals making a promise sent a 'goody bag' which included information on local stop smoking services and how to access free home fire safety checks (Community).	1,440 pledge promises; 50% of which to come from smoking households; changes in smoking behaviour; impact on health	3261 promises pledged of which 76% Gold and 47% of which had at least one smoker in the house. 83/500 (17%) follow-up surveys returned of which 51/63 (81%) reported making some change such as tried to quit (14%); quit (25%); or cut down (42%). 18/57 (68%) also reported changes in the behaviour of other adults in the house. More than half of respondents who stated there was someone in the home with a respiratory condition said this had improved.

Hovell et al (1994) USA ***Wahlgren et al (1997) 2 yr. follow up (USA)	RCT N=91 smoking parents of asthmatic child aged 6 - 17 years exposed to at least one cigarette per day by parent and requiring asthma medication	The experimental counselling group (ECG) received a 6 month series of counselling sessions designed to reduce SHS exposure. They used diaries during each 2 week monitoring period preceding clinic visits to record smoking patterns and child's exposure, children's peak flowmeter readings and children's symptoms. Behaviour modification techniques such as stimulus control, shaping and personal feedback tailored to each family. The monitoring control group (MCG) used the same monitoring measures as used in ECG but were not provided with a review of records or counselling. *** In the original study all families were given a debriefing pack and the control group (CG) were given results of SHS monitoring. The debriefing pack contained materials that included local smoking cessation resources and information about asthma and SHS exposure. A 'How to' booklet that described how to implement the counselling intervention on their own as well as diaries to record SHS exposure was included. Families in the control groups (MCG/CG) were given more detailed instructions on the materials and informed that the procedures had been effective in the ECG and encouraged to implement them at home (clinic).	Parent reports of child's SHS exposure in the home; SHS monitoring.	At 12 months the ECG sustained a 79% decrease in children's exposure to parents SHS compared to 34% decrease in the MCG and 42% in the CG. Pair wise comparisons showed ECG decreased exposure significantly greater ($P<0.01$) than the MCG and CG. Re SHS exposure in the home from all smokers, the ECG sustained a 51% decrease compared to 18% decrease in the MCG and 15% in the CG at 12 months. *** The ECG reported no reduction in median exposure levels, the MCG reported a 66% reduction and the CG reported a 25% reduction. The control groups reported a decrease in SHS exposure after the final 12 month visit suggesting the debriefing materials may have contributed to the reduction of children's exposure in these two groups. 21.4% subjects in the ECG maintained and eliminated child's exposure to zero compared to 3.6% in the MG and 3.8% in the CG. The mean SHS monitor value showed a significant decrease for all groups from baseline to final 12 month measurement.

Hovell et al (2000) USA	RCT N=108 mothers in low income homes who exposed their children (aged ≤4 year) to tobacco smoke in home	7 counselling sessions (based on shaping procedures) over 3 months (3 in person/4 telephone). At first session mothers set long-term goals to reduce children's exposure to SHS. Between sessions mothers recorded their smoking and child's exposure. Progress reviewed in subsequent sessions and solutions to barriers negotiated. Contingencies included counsellor 'praise' and low cost 'self rewards' (Home).	mothers' reporting of children's SHSE in the home and total exposure from all sources; children's' urine cotinine concentrations	both groups show a decline in reported SHSE in the home from baseline to end of counselling period (3months) but only slight decrease at 12 months follow-up (decline 87% in IG compared to 66% CG. Reported children's exposure to mothers smoke in the IG was 41% that of CG. Total SHSE from all sources showed similar declines with IG 46% that of CG (decline 83% in IG compared to 62% CG). At 12 months urine cotinine measures decreased in IG by 4% and increased in CG by 46% (at 12 months cotinine concentration in IG 57% that of CG)

Hovell et al (2009) USA	RCT N=150 mothers who exposed their children ≤ 4 years to 10 or more cigarettes per week	Combined intervention included an intervention targeting SHSE reduction with a smoking cessation component tailored to each participant. Treatment consisted of 10 in-person at home counselling sessions and 4 telephone counselling sessions over 6 months with additional pre- and post-quit telephone sessions. Counselling procedures included behavioural contracting, self-monitoring and problem solving. The control group received usual care plus all study measures (Home).	mothers reports on children's SHSE; mothers' smoking status; children's urine cotinine	From baseline to 6 months the intervention effect showed a larger decrease for children's' exposure to mothers' smoking in the home among IG (79.8%) compared to CG (54.9%); children's reported SHSE from all sources decreased 85.2% among IG compared to 57.3% among CG; mothers' mean smoking decreased 34.4% among IG compared to 5.1% among CG. The maintenance effect (6-18 months) - children's reported SHSE from all sources increased 3.2% among IG compared to 33.9% among CG; mothers' mean smoking increased 33.1% among IG compared to 4.6% among CG. Cotinine concentration was higher in CG from baseline and throughout follow-up period.

Kallio et al (2006) Finland	RCT N=1062 families of infants aged 5 months recruited from well-baby clinics.	The IG received individualised and targeted lifestyle counselling at each visit. The intervention comprised mainly dietary counselling with additional discussion on other cardiovascular risk factors such as smoking. At age 5 years, the child's parents received a booklet about the adverse effects of smoking. If family history was positive for heart disease, the importance of quitting smoking was repeatedly discussed. The CG families received regular health education material given to all families at Finnish well-baby clinics. Serum cotinine was measured for tobacco exposure (clinic).	self-reported parental smoking; cotinine	The proportion of smokers in both groups declined during the child's infancy and toddler years. The decline then slowed among fathers and stopped among mothers after the child reached 5 years. The smoking habits of parents in both groups did not differ; serum cotinine values correlated poorly with parents' reported amount of exposure.
Lanphear et al (2010) USA	RCT N=225 families of children aged 6-12 years, had physician-diagnosed asthma in previous 12 months, experienced ≥ 1 exacerbation requiring a unscheduled visit in past year, were exposed to smoke of ≥ 5 cigarettes per day in and around the house.	Families assigned to the IG received 2 active HEPA air cleaners. One air cleaner was installed in the main activity room and the other installed in the child's bedroom. There were no attempts to reduce tobacco use or other asthma triggers.	asthma exacerbation; asthma symptoms; tobacco smoke exposure; indoor air-borne particle levels; and exhaled nitric-oxide levels	Mean number of unscheduled asthma visits decreased 8.9% in the IG compared to 0.9% in the CG. There were 42 fewer unscheduled visits in the IG compared with those in the CG equivalent to a reduction of 18.5%. Significant reduction in air particle levels (IG 25% reduction v CG (P=.026)). No significant differences between groups with respect to parent-reported asthma symptoms, exhaled nitric-oxide levels, air nicotine levels or cotinine levels.

Liles et al (2009) *Linked to Hovell, 2009 (USA)*	RCT N=150 mothers who exposed their children ≤ 4 years to 10 or more cigarettes per week	Combined intervention included an intervention targeting SHSE reduction with a smoking cessation component tailored to each participant. Treatment consisted of 10 in-person at home counselling sessions and 4 telephone counselling sessions over 6 months with additional pre- and post-quit telephone sessions. Counselling procedures included behavioural contracting, self-monitoring and problem solving. The control group received usual care plus all study measures (Home).	smoking cessation	There were few quit attempts longer than 6 months. Mothers in the IG reported more 24hr quits (p = 0.019) and more 7 day quits (p = 0.029) than controls.
Ralston and Roohi (2008) USA	RCT N=42 smoking caregivers of children hospitalised for respiratory illness	Practical counselling with problem solving emphasis and inclusion of NRT (clinic).	self-reported smoking quit rates	14% intervention group self-reported quitter at 6 months compared to 5% control group. No group difference reached statistical significance.

Sockrider et al (2003) USA	RCT N=485 women enrolled at 28 weeks gestation with history of smoking prior to pregnancy and not smoked for at least 28 days prior to enrolment.	IG received one videotape and 5 newsletters for mothers (different set for partners) distributed by mail between 28 weeks gestation and 6 weeks postpartum. The newsletter included specific messages about protecting infants from SHSE, a smoke-free home sign, and tips on relapse prevention (Home).	Home smoking control index (HSCI); reported tobacco smoking in the home; nicotine monitors (for validation)	According to the HSCI 63% IG had a home smoking policy in effect at 3 months postpartum, 60% at 6 months and 64% at 12 months. Rates of home smoking control at 6 months post-partum were 82% among those who had quit smoking; 61% among those who had quit but relapsed; and 34% among those who did not quit. When compared with controls, smokers who received the smoking intervention were significantly more likely to limit smoking in the home. Home nicotine monitor concentrations were associated with self-reported SHSE in the home at 6 & 12 months postpartum. The final model indicated that having a home smoking policy at 3 months predicted policy at 6 months postpartum. Similar results were obtained when the same method was applied to 12 months postpartum data, using 6 months data to predict 12 months policy.

Wakefield et al (2002) USA	CT N=292 Low income parents of children aged 1 - 11 with asthma and at least one smoking parent in household.	IG received a letter with cotinine feedback, booklets on asthma and reducing SHSE; tailored feedback on reported levels of restrictions in the home and recommendations for further restrictions (or quitting if ban was already in place). Index parent contacted 1 week later to reinforce advice and allow for further clarification or advice if needed. Final phone call at 1 month to provide additional advice and encouragement (Home).	Reported ban on smoking in the home; smoking in car; cigarette consumption; urine cotinine concentrations.	Reported home smoking bans (CG + 6% v IG r+19%) differences not statistically significant; car ban changes - (CG+29% v IG +33%) differences not statistically significant; daily cigarette consumption declined modestly in both groups - differences not statistically significant. Change in urinary cotinine levels differences not statistically significant.
Wilson et al (2012a) UK	RFS N=54 mothers who smoked with at least one child younger than 6 years.	Four home-based visits over a 1-month period, which involved two 24 hr. measurements of indoor air quality (as measured by $PM_{2.5}$) and a motivational interview to encourage changes to smoking behaviour within the home. The IG received their air quality data as part of their motivational interview at visit 2; the control group received their air quality data at visit 4.	24 hr. average concentration of $PM_{2.5;}$ peak concentration of $PM_{2.5;}$ percentage of time when household $PM_{2.5}$ concentrations exceeded a health-based threshold of 35 µg/m^3; child's salivary cotinine. The views of mothers from the EG about their understanding of the intervention and the measures used were also analysed to assess the acceptability and utility of the intervention.	Of the 54 participants, 48 completed the study: 27 from the CG and 21 from the EG. Both groups experienced reductions in $PM_{2.5}$ concentrations. There was a significant difference in the EG ($p<0.05$) between visit 2 and visit 4 values for maximum $PM_{2.5}$ ($p=0.006$) and for percentage of time over 35 µg/m^3 ($p=0.017$), with average $PM_{2.5}$ approaching significance ($p=0.056$). There was no significant difference for salivary cotinine. The qualitative findings showed that mothers were able to understand the data they were shown; were shocked by the values measured in their

				homes despite being aware of the effects of SHS exposure. They appreciated the intervention taking place in their homes as it allowed them to have personalised data. Many mothers described how they had changed their smoking behaviours in their home and in particular were motivated to protect their own children as a result of the knowledge they had gained.
Wilson et al (2001) USA	RCT N=87 3-12 year old predominantly minority children seen for asthma in hospital emergency, in-patient and outpatient departments	3 nurse-led sessions employing behaviour changing strategies and basic asthma education spaced over 5 weeks with feedback on children's urinary cotinine levels (clinic).	Urinary cotinine/creatine (CCR) and number of acute asthma medical visits; number of hospitalisations, smoking restrictions in home, amount smoked and asthma control.	46% greater reduction in CCR in the intervention group v control. Proportion of children with more than one asthma-related visit decreased in the IG from 50% at baseline to 29.6% at 12 months follow-up compared to increase from 37.2% - 46.5% in the CG. Odds of having >1 visit were reduced by approx. two-thirds in IG compared to CG; proportion of children hospitalised decreased in the IG from 27.3%% at baseline to 6.8% at 12 months follow-up compared to decrease from 23.3% - 16.3% in the CG. Proportion of parents allowing smoking in the home decreased from 27.7% - 10% in IG compared to 40% - 30% in CG. Small change in

				amount smoked but no significant group difference Asthma Control no significant effect
Wilson et al, (2011) USA	RCT N=352 carers of children aged 3 - 12 years old who had medication and/or physician diagnosis suggesting persistent asthma and parent-reported exposure of child to SHSE confirmed by urine cotinine level >10ng/ml; >1 asthma-related medical visit in past year.	3 staged 'change' counselling sessions and 3 follow-up phone calls. Cotinine feedback given at each session. Follow-up at 6 & 12 months (clinic).	1. SHSE as measured by InCCR (cotinine-to creatine ratio); 2. asthma related health care utilisation (HCU): 3. asthma-related HCU counts; 4. asthma related emergency department visit hospitalisation;	LETS (intervention) group had lower but not significant fall in InCCR plus no difference in odds of >1 asthma related medical visit. Though in higher risk groups there was a lower InCCR compared with usual care. High risk kids in LETS had higher odds of living in a home with smoking restrictions than usual care. Therefore within the overall sample there was no statistically or clinically significant effect on the primary and secondary outcomes but among the high risk group LETS was associated with a significant decrease in SHSE compared to usual care. No change in controller medication, acquisition remained essentially the same.

Winickoff et al (2003) USA	Feasibility study N=100 smoking parents with child with smoke exacerbated/attributable conditions	3 brief counselling sessions (first face-to-face motivational interview (MI) with counsellor; 5th & 10th day 15 min follow-up MI sessions); written materials, NRT, proactive referral to quit helpline and fax to primary care provider (clinic).	completion 3 counselling sessions; quit attempts; cessation; NRT use; quitline use; and household smoking at 2 months	81% completed 3 counselling sessions; at 2 month follow-up 56% made a quit attempt ≥24 hour; 18% reported 7 day quit; 34% used NRT; 42% received additional counselling from quitline. Mean number of cigs smoked inside the home and car declined over 2 months (home 5.1 - 1.4; and car 2.5 - 1.4)
Yilmaz et al (2005) Turkey	RCT N=375 smoking mothers who accompanied a child < 16 years to the hospital for a healthcare visit for any primary complaint or well-child examination	Information provision on health risks of smoking (both intervention groups); child intervention group (CIG) risks of tobacco to child health explained; maternal intervention group (MIG) risks of tobacco to own health explained. Written document on how to quit smoking provided to both intervention groups (clinic).	smoking cessation; smoking location change; SHS exposure knowledge change	significantly higher ($P < 0.05$) cessation rates in both intervention groups though higher in child intervention group (CIG 24.3%; MIG 13%; Control 0.8%); significantly higher ($P < 0.05$) location change rates in both intervention groups though higher in child intervention group (CIG 73%; MIG 46.6%; Control 11.6%); Knowledge significantly better ($P<0.05$) in child group than other groups. Mean difference in baseline to post intervention scores = CIG 10%; MIG 3.5%; Control 3.87%. Thus provision of child health risks results in better results that maternal risks.

Zakarian et al (2004) USA	RCT =150 smoking mothers with children aged 4 years or less exposed to a minimum of 2 of their mothers cigarettes per day in home or car.	Mothers offered 7 counselling sessions delivered over 6 months. Sessions 1, 3 & 7 to occur at clinical sites; the others by telephone. Counselling included behavioural contracting for reducing children's SHSE, problem solving and positive reinforcement for successes. Counsellors assisted mothers with short/long-term goals for shaping their and other household members behaviour. Mothers were asked to use pictorial charts to self-monitor SHSE and smoking for 3 day intervals between sessions (child health centres).	Self-reported children's SHSE from mother's smoking & all sources; children's urinary cotinine concentrations; parents' smoking status	SHSE from mother's smoke declined in both groups from baseline to 6 months (P<0.001) and remained level at follow-up (IG decreased 71% v CG 60% baseline to follow-up). The same pattern occurred for SHSE from all sources (P<0.001) (IG decreased 58.6% v CG 66.5% baseline to follow-up). No significant group x time differences. Children's urine cotinine decreased 26.7% in IG compared to 26% in CG - no significant group or group x time difference; at 12 months follow-up 10.8% CG v 2.6% IG achieved 7 day quit status (biochemically verified)