Chapter 8
Home smoking restrictions: effects on exposure to SHS and smoking behaviour

Introduction

The concept of smokers refraining from smoking in their own homes is a new one in many parts of the world. Two lines of evidence suggest that this phenomenon will become more commonplace worldwide in the years to come. As documented below, localities well along in their battle of the tobacco epidemic with laws prohibiting smoking in public and workplaces have observed increases in the percentage of smokers reporting smoke-free homes (Borland *et al.*, 1999; Al-Delaimy *et al.*, 2007; Lund & Lindbak, 2007). Other studies have found a positive association between smokers working in smoke-free workplaces and reporting that they live in smoke-free homes (Farkas *et al.*, 1999; Gilpin *et al.*, 2000; Gower *et al.*, 2000; Merom & Rissel, 2001; Shopland *et al.*, 2006; Thomson *et al.*, 2006). Workplace smoking restrictions may make people more aware of the dangers to nonsmokers of secondhand smoke (SHS), and help establish norms regarding the inappropriateness of smoking around nonsmokers. After learning to cope with workplace smoking restrictions, a smoker may be more agreeable to having them in the home as well.

Prohibitions against smoking in the home setting are generally not mandated by law, and thus, could be considered "voluntary." A situation in which a home may be mandated to be smoke-free is in child custody cases; the court orders a parent to maintain a smoke-free home so that the child, often with asthma or other health problems, is not exposed to SHS (Sweda, 2004). Further, as population knowledge about the health dangers of SHS becomes more widespread, nonsmokers living with smokers may demand that the smoker not smoke inside the home. A smoker may feel coerced into adhering to this demand and not feel that it is voluntary. However, concern on the part of smokers for the health of nonsmoking family members, including children, may lead them to voluntarily agree to a smoke-free home. Also, if the smoker feels that a smoke-free home can directly benefit them (e.g. facilitate cessation) they may voluntarily implement a smoke-free home policy.

The purpose of this chapter is to examine the potential for this relatively new situation of smokers living in smoke-free homes to: (1) reduce child exposure to SHS, and (2) influence the smoking behaviour both of adults and youths.

Methodological issues

The reader is referred to Chapter 7 for a discussion of methodological issues including the literature review procedures, typical study designs, and conventions for reporting results. Also, Appendix 2 provides common definitions of smoking behaviour.

The studies described in this chapter differed considerably in how a smoke-free home was analysed. In some cases there were one or more categories included for partial restrictions, but in other cases smoke-free homes were contrasted to all others, regardless if the home was less than completely smoke-free. Including those with partial restrictions with those reporting no restrictions would reduce the chance of finding an association of a smoke-free home with the outcome of interest.

Scope of chapter

This chapter begins by reporting the prevalence of home smoking restrictions among smokers in various localities worldwide and summarising the available data characterising which smokers live in homes with smoking restrictions. Next, it presents evidence that smoke-free homes can reduce childhood exposure to SHS, even in households with adult smokers. This section also summarises previous reviews of interventions designed to reduce children's exposure to SHS in the home. The last main section reviews all the studies located to date regarding the effect of home smoking restrictions on adult and youth smoking behaviour.

The phenomenon of home smoking restrictions

Prevalence of smoking restrictions among smokers

There are data on the prevalence of smoke-free homes from respondents to population surveys, and these rates are highly related to smoking prevalence. However, some homes without smokers do not report that their home is smoke-free, as they never considered the necessity for a formal policy.

A more important measure reflecting progress in tobacco control in general and protection of nonsmokers from SHS in particular, is report of a smoke-free home among smokers (Table 8.1). Among studies that provide data on smoke-free homes among smokers, most still show a minority reporting a smoke-free policy. However, in some localities in recent years, a majority do report having smoke-free homes (e.g. 52.8% in a New Zealand study in 2004 (Gillespie *et al.* 2005), 58% of daily smokers and 80% of occasional smokers in Norway in 2006 (Lund & Lindbak, 2007), 58% in California in 2005 (Al-Delaimy *et al.*, 2008), 67% in Finland in 2005 and 55% in Sweden (European Commission, 2007)).

A survey conducted in the fall of 2005 covering the 25 European Union Countries and three additional European countries (Bulgaria, Croatia, and Romania) asked smokers whether they ever smoked when alone in their home (European Commission, 2007). This question is a fairly good proxy for identifying those who adhere to a completely smoke-free home policy. Overall, 18% of respondents claimed they never smoked at home when alone. This ranged from 67% of smokers in Finland to just 7% in Hungary and Croatia. Six countries had reported levels of 30% or higher (Finland, Sweden, Slovak Republic, Czech Republic, and Malta), and eight reported levels of 15% or less (Hungry, Croatia, Estonia, Greece, Belgium, Denmark, Estonia and Austria). These results underscore the disparities among countries.

Another key point is that for all countries with trend data, the proportion of smoke-free homes has increased over time both for the total population and for smokers. These trends may have been partly driven by reductions in smoking prevalence (U.S. Department of Health and Human Services, 2006), but there is evidence that other factors are involved. One review considered that comprehensive tobacco control programmes are likely to be important to changing social norms about where it is appropriate for smokers to smoke (Thomson *et al.*, 2006). Also, mass media educational programmes, that are part of such tobacco control programs and that address the SHS hazard or specifically promote smoke-free homes, may have played an important role. In California, there was a particularly sharp increase in smoke-free homes (everyone not just smokers) in just one year (1992 to 1993) from 38% to 51% (Gilpin *et al.*, 1999). During that time, the California Tobacco Control Programme's media campaign placed particular emphasis on protection of children from SHS in the home. Television spots depicted children coughing and breathing SHS from adults in the household.

There has been some speculation that smoking restrictions in public venues might lead to increases of smoking in private venues, such as homes. However, no evidence for such an effect was found in Ireland (Fong *et al.*, 2006) or New Zealand (Edwards *et al.*, 2008).

Who has a smoke-free home?

The question addressed in this section is: What are the characteristics of the population in general, and of smokers in particular, that report that smoking is not allowed in their homes?

Few studies addressed this question in a multivariate manner for the entire population. Univariate examinations of factors related to having a smoke-free home in Canada and the USA (Ashley *et al.* 1998; U.S. Department of Health and Human Services, 2006) provide some insight.

Table 8.1 Population prevalence of home smoking restrictions among *smokers*

Reference	Locality	Population	Year	Type of restriction	Prevalence %
Ashley *et al.*, 1998	Canada	443 adult smokers	1996	Partial Smoke-free	21.8 14.4
Norman *et al.*, 1999	California (USA)	Survey of 1245 adult smokers	1996/97	Smoke-free	43.3
Borland *et al.*, 1999	Victoria, Australia	800-900 adult smokers per survey year	Surveys 1995 1996 1997	Smoke-free 1995 1996 1997	 20.0 23.5 28.0
McMillen *et al.*, 2003	USA	362 & 669 smokers	Surveys 2000 2001	Smoke-free 2001 2002	 28.5 30.2
Pizacani *et al.*, 2003	Oregon (USA)	567 adult smokers	1997	Smoke-free	30.4
Gillespie *et al.*, 2005	New Zealand	1507 adult current smokers	2004	Smokers who do not smoke indoors at home	52.8
Borland *et al.*, 2006a	Canada, USA, UK, Australia	9046 adults in 4 countries	2002	Canada, partial / Smoke-free USA, partial / Smoke-free UK, partial / Smoke-free Australia, partial / Smoke-free	34.1 / 31.5 32.0 / 27.9 49.5 / 19.0 43.1 / 32.6
Fong *et al.*, 2006	Ireland and UK	Adults surveyed before (n=1679) and after (n=1185) law banning smoking in public places	2003/04 and 2004/05	Smoke-free 2003/04 2004/05	Ireland UK 15 18 20 24
Centers for Disease Control and Prevention, 2007a	USA	Current Population Surveys	Surveys 1992/93 2003	Smoke-free 1992/93 2001	 9.6 31.8
Al-Delaimy *et al.*, 2007	California (USA)	Survey of adult smokers 4558 in 1992 8581 in 1996 5470 in 1999 5278 in 2002 3821 in 2005	Surveys 1992 1996 1999 2002 2005	Smoke-free 1992 1996 1999 2002 2005	 19.4 35.9 46.8 51.9 57.8
Lund & Lindbak, 2007	Norway	Annual surveys	1995-2006	Smoke-free 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005	Occasional, Daily 26 10 26 12 45 20 52 21 46 19 49 24 53 26 66 25 64 42 75 43 80 58
European Commission, 2007	25 European Union countries and three other European countries	Survey conducted by Directorate-General Health and Consumer Protection of the European Commission	2005	Answer “no” to: Do you smoke inside your home when you are alone?	Mean: 18% Range: 7% to 67% 6 countries ≥ 30% 8 countries ≤ 15%

In Canada, in 1996, 34.6% (95% CI=32.3-36.9) of households were smoke-free (Ashley *et al.*, 1998). This percentage ranged from 42.9% (95% CI=39.6-46.2) in households with never smokers to 38.4% (95% CI=33.9-42.9) in households with former smokers to only 14.4% (95% CI=11.1-17.7) in households with current smokers. The number of daily smokers in the household was also related to the household being smoke-free: 44.3% (95% CI=41.5-47.1) smoke-free for no smokers, 17.5% (95% CI=13.7-21.3) for one smoker, and 7.4% (95% CI=3.7-11.1) for more than one smoker. Households with children 0-5 years were smoke-free 47.3% (95% CI=39.4-55.2) of the time, with children 0-17 years 42.5% (95% CI=32.9-52.1) were smoke-free, and with children 6-17 years 41.9% (95% CI=36.6-47.2) were. If no children were present, only 28.4% (95% CI=25.4-31.4) of households were smoke-free.

Data from the Current Population Survey, which was conducted in the USA, indicate that in 2001-2002, 66.03% of households were smoke-free (U.S. Department of Health and Human Services, 2006). Such homes were more prevalent among those of high (67.4%) versus low (57.8%) socioeconomic status. There were regional differences as well: northeast (64.9%), midwest (59.5%), south (65.2%) and west (75.2%). The states with the highest levels included Utah (83.1%), California (77.5%), and Arizona (75.9%), and those with the lowest percentages were Kentucky (50.9%), West Virginia (50.2%), and Tennessee (56.1%). Smoke-free homes were more prevalent among households without smokers (78.9%) than with smokers (25.6%). In households with a child younger than 13 years of age, overall 72.8% were smoke-free. However, if there was a smoker in the home, only 36.5% of such households were smoke-free compared to 85.2% if there were no smokers and a child younger than 13 years in the household.

Tables 8.2 and 8.3 present the correlates of persons reporting smoke-free homes in four countries (the USA, Canada, the UK, and Australia). Only a few studies examined the multivariate association and only in subgroups of the general population (Table 8.2), but many more considered the associations of reporting smoke-free homes among smokers (Table 8.3). There is evidence that in households with both adult nonsmokers and smokers, that there is some discrepancy in reporting home smoking rules (Mumford *et al.*, 2004), with smokers in mixed households less likely than nonsmokers in the same household to say the household is smoke-free. However, if smokers behave according to their own perceptions, their reports may be more relevant. In both Tables 8.2 and 8.3, the studies summarised examined a variety of factors, but none examined them all. Omitted factors, either because the data were not gathered or not used, can lead to significant multivariate correlates that might have lacked significance had the missing factors been included.

The studies summarised in Table 8.2 pertain to subgroups of the general US population (women, households with children, African Americans, and Hispanics). These studies all presented the results of multivariate analyses of a variety of factors that might be expected to be associated with having a smoke-free home. One study examined change over time in the proportion of families with children aged 18 years or younger, in which no one smoked on any days of the week in the home (Soliman *et al.*, 2004). This measure implies a smoke-free home, as it was in any week not just the most recent one. The authors compared data from the 1992 and 2000 National Health Interview Surveys, and found a decline in the “prevalence of exposure” in these families from 35% to 25%; this decline was demonstrated statistically to be greater than would be expected from the change in adult smoking prevalence over this period. The pattern of exposure among demographic and other groups was similar both years (combined year results are shown in Table 8.2), and the decline was observed among all the groups, but with higher educated groups showing somewhat greater declines.

Theses studies confirm that being a smoker is associated with a lower likelihood of reporting a smoke-free home (King *et al.*, 2005; Martinez-Donate *et al.*, 2007; Gonzales *et al.*, 2006; Shopland *et al.*, 2006). Three of the studies did not limit their population to families with children (King *et al.*, 2005; Shopland *et al.*, 2006; Martinez-Donate *et al.*, 2007), and two of them found that a young child in the home was correlated with report of a smoke-free home (Shopland *et al.,* 2006; Martinez-Donate *et al.*, 2007).

Table 8.2 Population studies reporting factors associated with having a smoke-free home from multivariate analyses

Reference/ location	Population / year of study	Factors associated with a smoke-free home								
		Smoking status	Young children present	Adult nonsmoker present	Believes SHS harmful	Age	Education	Race/ ethnicity	Employed in smoke-free workplace	Friends smoke
		Odds Ratios, 95% CI								
Soliman *et al.*, 2004 USA	15 601 families with children ≤ 18 years Model predicted smoking inside house 1992; 2000	NA	NA	NA	0.27 0.23-0.32	NA	<HS: 1.18 1.03-1.35 some college: 0.64 0.57-0.71 college grad: 0.36 0.30-0.43 post grad: 0.28 0.21-0.37 Reference: High school graduate	Hispanic: 0.36 0.30-0.42 Black: 0.74 0.65-0.84 Native American: 1.12 0.74-1.69 Asian: 0.57 0.41-0.80 Reference: Non-hispanic whites	NA	NA
King *et al.*, 2005 USA	1000 African Americans 2000-01	Former: 0.59 0.36-0.96 Current: 0.11 0.07-0.18 Reference: Never	NS	Marital status: Married: 2.89 1.76-4.73 Single: 1.79 1.03-3.1 Reference: Never married	Public should be protected: 2.69 1.36-5.34	NS	NA	NA	NA	Few: 0.45 0.28-0.73 Half: 0.28 0.16-0.47 Reference: None
Shopland *et al.*, 2006 USA	128 024 employed females who do not live alone 2001-02	Never: 3.80 3.40-4.25 Former: 3.04 2.69-3.43 Occasional: 2.79 2.39-3.25 Reference: Daily	<5 years: 1.37 1.24-1.52 Ref: none or <5	All never: 7.58 6.44-8.92 All former: 5.12 4.37-5.99 Mixed (1+ smokers): 1.38 1.20-1.59 Reference: All smokers	NA	25-44 years 0.87 0.78-0.98 45-64: 0.79 0.71-0.88 65+: 0.89 0.72-1.10 Reference: 18-24 years	HS:1.40 1.30-1.51 College:1.68 1.56-1.82 Reference <HS	Hispanic: 1.81 1.56-2.09 Black: 0.78 0.71-0.86 Asian: 1.42 1.15-1.76 Reference: White	1.41 1.33-1.50 Service: 0.92 0.85-1.00 Blue collar: 0.78 0.70-0.86 Reference: White collar	NA

Table 8.2 Population studies reporting factors associated with having a smoke-free home from multivariate analyses

		Factors associated with a smoke-free home								
Reference/ location	**Population/ year of study**	**Smoking status**	**Young children present**	**Adult nonsmoker present**	**Believes SHS harmful**	**Age**	**Education**	**Race/ ethnicity**	**Employed in smoke-free workplace**	**Friends smoke**
Gonzales *et al.*, 2006 Albuquerque, New Mexico, USA	269 Hispanic mothers of children 2-12 years 2003-04	Non-smoker: 5.47 2.50-11.95 Reference: Smoker	NA	11.17 4.56-27.38	NA	NS	NS	Born in the USA 0.17 0.06-0.50 Reference: In Mexico	NA	NA
Yousey, 2006 Midwestern USA	226 parents of children in Head Start programmes	NA	NA	Marital status and number of residents: NS	Attitude scale 0.83 0.76-0.91 Higher value implies lower agreement	NS	NS	English: 19.9 3.0-131.6 Reference: Spanish question-naire	NA	NA
Martinez-Donate *et al.*, 2007 San Diego, California, USA	1103 adults of Mexican decent 2003-04	Former: 2.47 1.27-4.81 Never: 2.55 1.14-5.75 Reference: Smoker	2.03 1.18-3.51	Smoker: 0.45 0.26-0.78 Reference: Nonsmoker	Aversion to SHS: 2.82 1.41-5.63	Per year 0.98 0.96-0.99	Per year 0.81 0.70-0.95	Accultu-ration 1.50 1.10-2.05	NS	NA

NA = Not analysed or not applicable
NR = Not reported, but included in multivariate model
NS = Not significant
HS = High school education

Table 8.3 Population studies reporting factors associated with smokers living in a smoke-free home from multivariate analyses

Reference, sample size, study year	Factors associated with a smoke-free home									
	Child present	Adult Non-smoker present	Believes SHS harmful	Household income	Age	Sex	Education	Race/ ethnicity	Intention to quit, cigarette consumed	Friends smoke
	Odds ratios, 95% CI									
Gilpin *et al.*, 1999 California, USA N=8904 1996	Child and adult: 5.7 4.6-7.0 Adult nonsmoker only: 4.0 3.3-4.8 Child, no adult: 2.7 2.1-3.4 Versus no child no adult		5.1 2.3-10.9	NA	NR	NR	NR	NR	NA	NA
	NA		NA	NA	25-44 years 0.8 0.6-0.9 45-64: 0.4 0.3-0.5 65+: 0.3 0.2-0.4 Versus 18-24 years	F: 0.7 0.6-0.8	NS	Hispanic: 2.5 2.0-3.1 Black: 0.6 0.5-0.9 Asian: 1.4 1.1-1.8 Versus White	NA	NA
Norman *et al.*, 1999 California, USA N=1245 1996	6.1 2.8-13.7	NA	NA	1.19; 1-1.4	18-24 years 4.5 1.6-12.6 25-34: 2.1 1.1-4.0 35-54: 0.8 0.4-1.5 Versus 55+ years	F: 0.6 0.4-0.9	NA	Hispanic: 1.5 0.8-2.8 Black: 0.3 0.1-0.8 Other: 0.8 0.4-1.9 Versus White	NA	No friends smoke: 4.1 1.2-13.5 Few smoke: 4.1 2.0-8.3 <Half smoke: 1.7 0.8-3.9 Half smoke: 1.3 0.6-2.8 Versus Most smoke

Table 8.3 Population studies reporting factors associated with smokers living in a smoke-free home from multivariate analyses

	Factors associated with a smoke-free home									
Reference, sample size, study year	**Child present**	**Adult Non-smoker present**	**Believes SHS harmful**	**Household income**	**Age**	**Sex**	**Education**	**Race/ ethnicity**	**Intention to quit, cigarette consumed**	**Friends smoke**
	Odds ratios, 95% CI									
Merom & Rissel, 2001 Australia N=4270 1998	<6 yrs: 3.8 3.1-4.7 ≥6 yrs: 1.9 1.5-2.3 Other adult: 0.9 0.7-1.1 Versus lives alone		NA	NA	35-54: 0.7 0.6-0.9 55+: 0.8 0.6-0.9 Versus 16-34 years	F: 0.8 0.7-1.0	HS: 1.3 1.1-1.5 College: 1.4 1.1-1.7 Versus <HS	Non-English background: 1.5 1.2-1.9	NA	NA
Kegler & Malcoe, 2002 Oklahoma, USA N=200 2000	NA	NS	4.56 1.3-16.2	NS	NS	NS	NA	NS	Quit attempt in last year: 2.5 1.2-5.4 <10/day: 3.3 1.5-7.7	NS
Okah *et al*., 2002 Inner city (Kansas City, Kansas, and Missouri) USA N=598 2000	2.6 1.7-4.1	2.1 1.8-3.6	NA	NA	0.98 0.96-1.00	NS	NS	NS	NS	NS
Pizacani *et al*., 2003 Oregon, USA N=147 1997	3.0; 2.1-4.4	4.3 2.5-7.3	6.6 3.6-12.3	>$35K 2.5 1.7-3.5	NA	NA	NA	NA	NA	NA

Reference, sample size, study year	Factors associated with a smoke-free home									
	Child present	**Adult Non-smoker present**	**Believes SHS harmful**	**Household income**	**Age**	**Sex**	**Education**	**Race/ ethnicity**	**Intention to quit, cigarette consumed**	**Friends smoke**
	Odds ratios, 95% CI									
Okah *et al.*, 2003 Inner city (Kansas City, Kansas, and Missouri, USA) N=383 2001	1.7 1.0-3.0	2.3 1.2-4.6	NA	NA	NS	NS	NA	NA	Preparation: 3.3 1.7-6.2 Versus Contem-plation Progression: 4.2 2.2-7.9 Versus no progression	NA
Borland *et al.*, 2006a USA, UK, Canada, Australia N=4053 2002	Infant: 3.7 2.1-6.4 Pre-school: 1.4 1.0-2.1 Preteen: 1.1 0.8-1.6 Teen: 1.2 0.9-1.8 Versus none	Non-smoker: 5.2 2.3-11.6 Other smoker: 2.2 0.8-6.1 Versus lives alone	NS	NS	18-24: 3.6 1.3-10.4 25-39: 1.7 0.8-3.5 40-54: 1.2 0.6-2.5 Versus 55+ years	NS	NS	Minority status: NS	NS Heaviness of smoking: 0.8 0.7-0.8	Intend to quit: In one mo: 1.6 1.0-2.5 In six mo: 1.4 1.0-2.0 >6 mo: 1.5 1.1-2.0 Versus No intent
Berg *et al.*, 2006 Rural Kansas, USA N=472	2.2 1.1-4.3	1.6 1.1-2.5	NA	NA	NS	M: 1.4 1.0-2.2	NA	NA	Motivation scale: 1.03 1.01-1.05	3-5 of five best friends smoke: 0.6 0.4-0.9 Nicotine dependence scale: 0.8 0.7-0.9

Table 8.3 Population studies reporting factors associated with smokers living in a smoke-free home from multivariate analyses

	Factors associated with a smoke-free home									
Reference, sample size, study year	**Child present**	**Adult Non-smoker present**	**Believes SHS harmful**	**Household income**	**Age**	**Sex**	**Education**	**Race/ ethnicity**	**Intention to quit, cigarette consumed**	**Friends smoke**
	Odds ratios, 95% CI									
Shields, 2007 Canada N=4394 2005	2.7 2.2-3.3	NA	NA	NA	15-24: 3.1 2.0-4.9 25-34: 2.0 1.9-2.1 Versus 35-44 years	M: 1.3 1.1-1.6	HS: 1.9 0.6-5.8 College: 2.4 1.3-4.3 Versus <HS	NA	NA	NA

NA = Not analysed or not applicable
NR = Not reported, but included in multivariate model
NS = Not significant
HS= High school education
F=Female
M=Male

Attitudes and beliefs about the danger posed by SHS were examined in four of the studies, and all found an association with report of a smoke-free home (Soliman *et al.*, 2004; King *et al.,* 2005; Yousey, 2006; Martinez-Donate *et al.*, 2007). While all but one of the studies examined age, just two found an association. Employed women 25-64 years were less likely to report restrictions than younger women 18-24 years (Shopland *et al.* 2006), and among San Diego residents of Mexican decent, younger age was associated with less likelihood of a smoke-free home (Martinez-Donate *et al.*, 2007). Only one of the three studies that included both sexes examined the association of respondent sex (not shown in Table 8.2) with report of a smoke-free home, and found no association (Martinez-Donate *et al.*, 2007). In three of the five studies that examined educational attainment, having a high school education or greater was associated with report of a smoke-free home than not graduating from high school (Soliman *et al.*, 2004; Shopland *et al.*, 2006; Martinez-Donate *et al.*, 2007). The study by Martinez-Donate *et al.*, 2007 also found that persons of higher acculturation were more likely to have smoke-free homes. This is in contrast to all four studies where persons of Hispanic ethnicity/lower acculturation could be compared to non-Hispanic whites. In these studies, Hispanic ethnicity or less acculturation (immigrant or need to take the survey in Spanish) was associated with greater levels of smoke-free homes (Soliman *et al.*, 2004; Gonzales *et al.*, 2006; Shopland *et al.*, 2006; Yousey, 2006). Asian households were also more likely to be smoke-free than non-Hispanic white households (Soliman *et al.*, 2004; Shopland *et al.*, 2006). It was found that report of employment in a smoke-free workplace and type of occupation were correlated with having a smoke-free home (Shopland *et al.*, 2006). In the study of US African Americans, having friends who smoke was associated with a report of a smoke-free home.

Another group of studies involving only smokers considered the presence of children or nonsmoking adults in the home (Table 8.3). In general, these factors were highly correlated with the smoker reporting a smoke-free home. In studies that examined attitudes or beliefs about the harmfulness of SHS (see also Chapter 5), with the exception of one study (Borland *et al.*, 2006a), there was a relationship with these factors and having a smoke-free home.

Since household income and educational attainment are related, studies tended to include one or the other of these factors, but not both. While respondents tend to freely report their educational status, many will not divulge their income, so most studies analysed education. Only one study in Table 8.3 included both (Borland *et al.*, 2006a); and neither was significantly related to having a smoke-free home. In the majority of studies, higher income or higher educational attainment was associated with the smoker having a smoke-free home. Many of the studies examined age and sex. In the studies that showed a significant effect for the age of the respondent, younger smokers were more likely to report a smoke-free home, and in those that showed a significant effect for sex, female smokers reported having a smoke-free home less often than male smokers. Younger smokers may be more open to adoption of a smoke-free home, as they have not yet solidified their smoking behaviour, and tend to smoke fewer cigarettes per day (CPD) than older smokers (Al-Delaimy *et al.*, 2007). Heavier smokers might find it more inconvenient than lighter smokers to tolerate not smoking inside the home. If women are at home more than men, a smoke-free rule might be more difficult for them to tolerate as well.

In California, smokers of Hispanic ethnicity were more likely to report a smoke-free home, and African Americans were less likely to report one than non-Hispanic whites (Gilpin *et al.*, 1999; Norman *et al.*, 1999). Few Hispanic women (mostly of Mexican descent in California) smoke, and occasional smoking among Hispanic men is prevalent (Palinkas *et al.*, 1993). In Australia, a non-English background was significantly associated with greater report of a smoke-free home (Merom & Rissel, 2001). However, a four-country study that examined "minority status" failed to find an independent correlation (Borland *et al.*, 2006a). One study that included working in a smoke-free workplace (factor not included in Table 8.3) (Merom & Rissel, 2001) found that it was associated with a higher likelihood of reporting a smoke-free home compared to not being employed. Employment in a non smoke-free workplace showed a marginally higher likelihood of reporting a smoke-free home than the unemployed. Half the studies

that examined having friends who smoke (Norman *et al.*, 1999; Kegler & Malcoe, 2002; Okah *et al.*, 2003; Berg *et al.*, 2006) found that smokers with friends who smoke were less likely to have a smoke-free home (Norman *et al.*, 1999; Berg *et al.*, 2006).

Two studies specifically looked longitudinally at factors predictive of adoption of a smoke-free home (Okah *et al.*, 2003; Borland *et al.*, 2006a). One study was clinic-based and participants were part of a smoking cessation program (Okah *et al.*, 2003). Being in the preparation stage for quitting (defined in this study as intending to quit in the next month and having a quit attempt of a day or longer in the past year) at baseline or advancing their stage of quitting by follow-up were both associated with adopting a smoke-free home. The other study was a population-based longitudinal study, and it found baseline intention to quit was associated with adoption of a smoke-free home (Borland *et al.*, 2006a). This study also included an index for "heaviness of smoking," which was inversely related to adoption of a smoke-free home. Two cross-sectional studies included variables related to heaviness of smoking: daily cigarette consumption (Kegler & Malcoe, 2002) or addiction level (Berg *et al.*, 2006). Both were similarly inversely related to adoption of a smoke-free home.

The two longitudinal studies of adoption of smoke-free home policy suggest that smokers thinking about quitting are more likely to institute a smoke-free policy; they may adopt a smoke-free home policy when they make a quit attempt. Personal desire to quit, concern for the health of others in the household, and cultural factors may all play a role in smokers' adoption of a smoke-free home.

Protection of children from exposure to secondhand smoke in the home

Protection of children and adult nonsmokers from secondhand smoke (SHS) in the household is an important public health goal (WHO, 1999; U.S. Department of Health and Human Services, 2000). By 2010, the US goals are to reduce to 10% the fraction of children age 6 years or younger who are exposed to SHS in the home, and to reduce to 45% the fraction of nonsmokers age 4 years and older who exhibit a serum cotinine level >0.10 ng/ml (Healthy People 2010 initiative, http://www.healthypeople.gov/).The goal outlined by the WHO emphasised educational strategies to reduce SHS exposure in the home, recognising that smoke-free workplace legislation will help smokers accept that they should not smoke in their homes as well (WHO, 1999). Since children, especially pre-school aged, spend most of their time in the home or in the family automobile, having these settings smoke-free is the most effective step parents can take to reduce their children's exposure to SHS (see also Chapters 5 and 6).

Methods available to assess exposure to SHS are mentioned in Appendix 1. It can be costly and logistically complicated to obtain biological samples for determination of cotinine levels, or other biologic markers, on a large-scale population basis. Thus, many surveys ask respondents to estimate hours of SHS exposure that they and/or their children have experienced in the home or in other settings, and these reports, along with other data describing smoking habits, have been compared to various biologic measures and found to correlate reasonably with them as in the example study described below.

This study compared detailed parental reports of smoking to their child's urinary cotinine levels (Wong *et al.*, 2002). It included 146 asthmatic children (7 years and older) and parent/guardian pairs from low-resource homes (Los Angeles, California) in which at least one adult smoked. Log transformed urine cotinine level was used as the dependent variable in a multivariate regression analysis with independent variables describing factors related to child exposure. These included number of smokers in the household, maternal and paternal smoking status, total number of cigarettes smoked per day in the home, total number of hours smoked per week by all household smokers in three locations (inside, directly outside the home, and in the car), and total number of hours the child was present when smoking occurred in each of these locations. In addition, a three-level variable for home smoking restrictions was included: no smoking ever allowed inside, partial restrictions (some rooms, some circumstances), and no restrictions on smoking indoors. Results indicated that the smoking restriction variable was the most important determinant of urinary cotinine level, followed by maternal smoking, total number of cigarettes smoked indoors

at home, and paternal smoking. The first three factors accounted for 45% of the variance in urinary cotinine levels. The authors conclude that questionnaires can be kept relatively simple and ask only about these factors. While prediction of the biologic marker was not perfect, the questionnaire data provides a useful indication of a child's exposure to SHS in the home.

This section first examines levels of exposure typically experienced by children in the home. It then presents the evidence to support the assertion that a smoke-free home can protect children from SHS. Next, it summarises reviews of interventions designed to protect children from exposure to SHS in the home.

Prevalence of child exposure to SHS in the home

The largest international study that provides information regarding exposure to SHS in the home is the Global Youth Tobacco Survey (GYTS) (GTSS Collaborative Group, 2006). Students aged 13-15 years from 132 countries participated in the GYTS, from 1999 through 2005, and were asked if they had been exposed to SHS on one or more days in the past seven days. The data presented in Table 8.4 may not be representative of entire countries or regions, since the surveys were conducted in selected localities within the respective countries. The collective results of this survey suggest that worldwide nearly half of young people aged 13-15 years who are never smokers were exposed to SHS at home (43.9%) in the last seven days (Table 8.4).

Table 8.4 Any exposure to SHS at home in the last seven days according to results from Global Youth Tobacco Survey between 1999-2005 (GTSS Collaborative Group, 2006)

WHO region (by descending level of home SHS exposure)	Number of sites sampled	Percentage reporting exposure to SHS at home	95% CI	Had one or more parents who smoke (%)	Range for SHS exposure at home for jurisdictions within each region (and selected results)	Proportion of jurisdictions with ≥ 50% exposed (n)
Europe	29 in 26 countries	78.0	±2.6	59.6	Sarov, Russia (36.5%) to Republic of Serbia (97.7%)	89.7% (26/29)
Western Pacific	30 in 16 countries	50.5	±3.2	59.7	Puyang, China (32.6%) to Denang, Viet Nam (65.8%)	50.0% (15/30)
Americas	98 in 37 countries	41.6	±2.6	41.0	Virgin Islands (British) (10.4%) to Buenos Aires, Argentina (71.0%)	13.3% (13/98)
Eastern Mediterranean	25 in 21 countries	37.6	±3.5	35.6	Oman (21.0%) to Gaza Strip (87.0%)	28.0% (7/25)
South East Asia	11 in 7 countries	37.0	±1.6	43.5	Bhutan (29.2%) to Biratnagar, Nepal (84.7%)	54.5% (6/11)
African	37 in 25 countries	30.4	±3.8	22.7	Addis Ababa, Ethiopia (14.9%) to Bamako, Mali (59.9%)	2.7% (1/37)
Total	230 in 132 countries	43.9	±2.5	46.5	Virgin Islands (British) (10.4%) to Republic of Serbia (97.7%)	29.6% (68/230)

The WHO region with the highest level of SHS exposure at home was Europe (mean of 78.0%) and the lowest level was in Africa (mean of 30.4%).

Overall, the GYTS results show that there was only a small difference between those reporting SHS at home (43.9%) and those reporting that they have one or more parents who smoke (46.5%), suggesting that exposure to SHS at home is correlated with population smoking prevalence. It might be expected that countries with relatively higher levels of smoke-free homes among smokers would show a gap in these figures, with lower exposure rates than parental smoking prevalence. Worldwide, relatively few sites showed home SHS exposure rates much lower than parental smoking rates. In fact, in many cases the exposure percentage was somewhat higher than the rate of parental smoking, perhaps because of household members, other than parents, who were smokers.

Other studies of child or youth exposure to SHS in the home are described in the Table 8.5. The measure of exposure to SHS varies considerably so that the studies are not directly comparable. Report of a smoke-free home may not mean that exposure does not take place inside the home, particularly if the question asking about home smoking rules did not include an alternative for partial restrictions allowing smoking under particular circumstances (e.g. by visitors, in bad weather, only in some rooms, when children not present, etc.). As mentioned previously in the chapter, the prevalence of smoke-free homes is increasing over time, particularly in localities with a tobacco control programme with a media component emphasizing the importance of protecting children from SHS.

Do rules about smoking in the home reduce children's exposure to SHS?

All of the studies summarised in Table 8.6 concern exposure of children to SHS in households with and without some rules or measures being taken to protect them. Children with asthma whose parents smoke are a group of particular concern; Table 8.6 separates the studies dealing with asthmatic children. The studies reviewed include diverse measures of exposure, ranging from estimated hours of exposure per day or week to biochemical measures of cotinine (urine, serum, hair) or nicotine (hair). Further, the variable capturing rules about smoking inside the home sometimes included precautions, such as only smoking by an open window and not in the presence of a child, along with more strict rules up to a completely smoke-free policy. Also, while some studies included covariates related to sociodemographic factors and the smoking behaviour of the household adults, others did not.

Nevertheless, only one study reviewed failed to find a direct relation between increased SHS exposure to children and smoking allowed inside the home (Al-Delaimy *et al.*, 2001b). Children 3 months to 10 years of age (n=112) were the subject of this study that compared hair nicotine levels in children in households with and without smokers, as well as in households with smokers but a smoke-free policy. In children reportedly exposed to smokers, hair nicotine levels were higher than in those not exposed to smokers (median 0.80 ng/mg of hair versus <0.10 ng/mg, respectively, $p<0.0001$). An even greater difference was observed for smoking mothers versus nonsmoking mothers (median 1.38 ng/mg versus <0.10 ng/mg, $p<0.0001$). The difference was less pronounced if the father smoked or not (0.61 ng/mg versus 0.10 ng/mg, $p=0.0085$). Typically, young children would be expected to spend more time in the home with the mother present than the father. In families with smokers who smoked only outside, the distribution of hair nicotine levels was reported to be similar (but data not presented) to that in families in which smokers smoked inside. The length of time the child spent inside the home was also related to hair nicotine levels. No multivariate analysis was performed, so it is unknown what effect time spent away from home might have on the relationship between smokers smoking only outside on hair nicotine levels.

An example of a positive study with a multivariate analysis was presented in the introduction to this main section (Wong *et al.*, 2002). The purpose of this study was to determine whether questionnaires designed to capture information about exposure of children to SHS in the home needed to be brief or detailed. However, a number of the other studies (Table 8.6) used similar measures, and like the Wong *et al.* (2002) study, besides home smoking rules, some measure of intensity of smoking in the home was significantly associated with the particular biomarker being analysed

Table 8.5 Exposure of children to SHS in the home

Reference/location	Population	Year data collected	Measure of SHS exposure	Results	Comments
Jarvis *et al.*, 2000 UK	Nationally representative cross-sectional surveys of secondary school children (11-15 years)	1988, 1998	Saliva cotinine concentrations	Saliva cotinine decreased from OR=0.96; 95% CI=0.83-1.11 ng/ml in 1988 to OR=0.52; 95% CI=0.43-0.62 ng/ml in 1998.	The authors attributed the decline to an increase in nonsmoking households and cessation among parents. Among those living with a smoking parent, there was little change.
Wakefield, *et al.*, 2000a USA	Survey of 17 287 high school students aged 14-17 years	1996	Report of having a smoke-free home or partial restrictions regarding smoking inside the home	Close to half (48.2%) of students reported having a smoke-free home, and another quarter (27.2%) reported partial restrictions.	
Helgason & Lund, 2001 5 Nordic countries (Sweden, Norway, Denmark, Iceland, and Finland)	A mailed cross-sectional community-based survey of parents of children aged 3 years; 3547 households participated	1995-1996	At least weekly exposure inside the home	The reported levels of no SHS exposure in these homes was 63% in Denmark, 63% in Iceland, 76% in Norway, 89% in Sweden, and 95% in Finland.	Exposure to SHS was related to parent educational status and attitudes and awareness of the health effects of SHS on children.
Stephen *et al.*, 2003 Nogales, Arizona, USA	Survey of students (10-12 years) and parents (n=631 pairs)	1996	Report of smoking inside the home	A majority of Mexican students (59.3%) had smokers living in their homes. Someone smoking inside was somewhat less common (50.0%). These numbers were lower for the Arizona students, 43.0% and 42.0%, respectively.	A larger proportion of homes with smokers appeared to be smoke-free in Nogales, Sonora than in Nogales, Arizona.
Soliman *et al.*, 2004 USA	National Health Interview Surveys. Homes with children aged ≤ 18 years; 4418 families in 1992 and 11 183 in 2000	1992, 2000	Adult report of smoking inside the home	SHS exposure in homes with children declined from 35.6% to 25.1% from 1992 to 2000. This was greater than the decline in smoking prevalence (26.5% to 23.3%).	Home SHS exposures were more prevalent among non-Hispanic whites than among African Americans, Asian Americans, and Hispanics. Exposures declined across all groups, but with greater gains in higher education and income groups.
Leung *et al.*, 2004 Hong Kong	Population-based birth cohort of 8327 newborn infants followed for 18 months	1997	Having a smoker in the household. Household smokers reported to smoke within 3 meters or beyond 3 meters of the infant.	41.2% of infants were exposed to a smoker in the household. 25.6% of these smokers smoked within 3 meters of the infant.	

Table 8.5 Exposure of children to SHS in the home

Reference/location	Population	Year data collected	Measure of SHS exposure	Results	Comments
Lund & Helgason, 2005 Norway	National random samples of households with children aged 3 years old. In 1995, 609 households participated. In 2001, 613 households participated.	1995, 2001	If smokers resided in the home, the respondent was asked how often they or their partners smoked indoors when their children were present. Respondents could answer every day, several times a week, about once a week, less than once a week, and never. Whether the home had some sort of rule restricting smoking.	In these households reported exposure of children (any, even less than once a week) to SHS was 18% in 2001. This was down from 32% in 1995. In 1995, 67% of families had imposed some sort of rule to limit smoking by family members or others indoors. This increased to 85% in 2001.	The prevalence of parental smoking was not significantly different between the two survey years.
Health Canada, 2006 Canada	Canadian Tobacco Use Monitoring Survey Households with children under the age of 12 years from over 21 976 respondents age 15 years and older	2006	Smoking inside the home every day or almost every day	The survey found that 15% of households reported at least one person who smoked inside the home every day or almost every day. Also, 9.2% of children under 12 were regularly exposed to SHS at home. This varied from 3.0% in British Colombia to 18.4% in Quebec.	
Healton *et al.*, 2007 USA	American Legacy Foundation national survey of young people 12-17 years	2003	Report of daily exposure	Altogether, 13% of young people aged 12-17 were exposed to SHS daily in homes.	
Bird *et al.*, 2007 Mexico	506 students (11-13 years old) from randomly selected schools, Ciudad Juarez	2000	Report of any exposure in past seven days	Overall, 41.3% were exposed to smoking in the home in the past seven days, and over 38% had one or more parents who smoked.	Exposure was highest in students from public low-socioeconomic status (SES) schools (57.4%) versus private high-SES schools (26.3%). Only students attending school in a high-SES setting reported SHS exposure at home (27.5%) that was lower than tobacco use by their parents (32.6%) (i.e. suggestive of some impact from smoke-free home rules).
Al-Delaimy *et al.*, 2007 California	Households from the California Tobacco Surveys with children under 6 years	1993, 1996, 1999, 2002, 2005	No adult smoker in home, or if adult smokers live in home, home is reported to be smoke-free (no one smoked indoors at any time or under any circumstances).	In homes where all adults smoke, the percentage of children unexposed to SHS increased from 18% in 1993 to 57.8% in 2005. If mixed households (adult smokers and nonsmokers) the percentage of children protected increased from 43.2% in 1993 to 79.6% in 2005.	Having a nonsmoking adult in the household may provide advocacy for making the home smoke-free.

(Bakoula *et al*., 1997; Wakefield *et al*., 2000a; Blackburn *et al*., 2003; Spencer *et al*., 2005). In another study of reported hours of SHS exposure, the number of smokers in the household was significant in the multivariate analysis (Biener *et al*., 1997).

A study that examined multiple measures of infant (≤ one year) exposure to SHS in 49 families is worth noting because of the consistency of findings across measures (Matt *et al*., 2004). Three types of families were compared: all adults in the family were nonsmokers (n=17); at least one adult smoker in the family, but the smoker only smoked outside or in the absence of the infant (n=17); and at least one adult smoker and no steps were taken to protect the infant (n=15). Families were recruited in San Diego County by advertisements in clinic sites and the local news media. The families were eligible only if the infant was not being breast fed. Exposure to toxins from SHS was measured at multiple times in a variety of ways, including nicotine in household dust, indoor air, infant hair, and on household surfaces, and cotinine levels in infant urine and hair. Infant urine cotinine was 0.32 (95% CI=0.19-0.47) ng/ml in the nonsmoking households, 2.88 (95% CI=1.22-5.79) ng/ml in the protective households, and 13.02 (95% CI=8.01-20.81) ng/ml in the smoking households. Hair cotinine was 0.08 (95% CI=0.05-0.11) ng/mg in the nonsmoker households, 0.52 (95% CI=0.20-0.92) ng/mg in the protective, and 1.05 (95% CI=0.55-1.72) ng/mg in the smoking households. Hair nicotine was 0.53 (95% CI=0.25-0.86) ng/mg in the nonsmoking households, 2.65 (95% CI=1.10-5.34) ng/mg in the protective, and 5.95 (95% CI=3.25-10.37) ng/mg in the smoking households. There was no measurable surface contamination in homes without smokers. In homes with smokers but protective of infants, mean surface contamination in the living room was 10.08 (95% CI=0.01-21.10) $\mu g/m^2$, and it was 8.19 (95% CI=2.69-14.98) $\mu g/m^2$ in the infant's bedroom. In non-protective homes, these levels were 51.33 (95% CI=19.17-32.16) $\mu g/m^2$ and 41.85 (95% CI=24.71-59.09) $\mu g/m^2$, respectively. The other measures of contamination were nil in the nonsmoking families, and generally much higher (up to a factor of 7) in the families not trying to protect their infants compared to the families that did. It appears that infants in families with smokers who try to protect their child are still exposed to between 5 and 10 times more SHS toxins as in families without smokers. These concerned families do, however, manage to at least halve their infant's exposure when compared to those who take no steps to protect their infants. When smokers smoke in the home when the infant is not present, contaminants accumulate; they may even accumulate from contact with the smoker's skin and clothing, even when the smoker does not smoke inside the home.

A large international study conducted in 2006 examined 1284 households from 31 countries fairly evenly distributed in three regions: Latin America, Asia, and Europe and the Middle East (Wipfli *et al*., 2008). Households had at least one child younger than 11 years; hair samples were collected for determination of hair nicotine concentrations if smoking was not permitted inside the household (smoke-free). A multilevel linear model of households with male smokers allowed for a country-specific intercept, and with child hair nicotine concentrations as the dependent variable it examined the following independent variables: whether the household was smoke-free, the number of smokers in the household, whether the mother smoked, cigarettes smoked per day by all smokers and by female smokers only, whether at least one smoker smoked near the child, and the child's age. The model estimated that hair nicotine concentrations were 2.6 (95% CI=2.0-3.3) times higher in children residing in non smoke-free households compared to those that were smoke-free. A similar analysis of air nicotine concentrations, that included the number of smokers in the household, the number of cigarette smoked per day by all smokers, whether the household was smoke-free, and mean outdoor temperature, showed homes without a smoke-free policy to have 12.9 (95% CI=9.4-17.6) times the air nicotine concentration as those with such a policy.

The results of these studies (Table 8.6) suggest that while partial restrictions on smoking indoors in the home might reduce exposure of children to SHS toxins compared to no restrictions at all, a smoke-free home provided the best protection to children in homes with an adult smoker present. When analysing the factors related to SHS exposure, besides the presence of smoking restrictions, measures of the intensity of smoking in the household appeared to be significantly related.

Table 8.6 Clinic-based (unless otherwise indicated) studies reporting exposure of children to SHS in homes with and without smoking restrictions

Reference/ location	Population/ year data collected	Analysis	Exposure measure(s)	Home smoking restriction variable	Results	Comments
Children in general						
Bakoula *et al.*, 1997 Athens, Greece	2108 Children ≤ 14 years who attended hospital outpatient clinics 1991-92	Multiple linear regression of log cotinine to creatinine ratio. Model included child's age and gender, day of the week sample taken, home floor area, non-central versus central heating, and maternal and paternal daily cigarette consumption	Urinary cotinine to creatinine ratio (CCR)	Precautions by parents taken to reduce exposure: never smoking in presence of child, or only in certain areas, or with the windows open	Less by 38% (24-54%) if precautions taken by parents. Also significant: cigarettes smoked when the child was at home, child's age, sample taken any day but Monday, floor area of the home, heat central versus noncentral, maternal education, paternal education.	Having a smoke-free home could not be evaluated separately.
Biener *et al.*, 1997 Massachusetts	Population survey of 1606 adolescents 12-17 years Analysis in subset of 679 families with at least one adult smoker 1993-94	Multiple linear regression of log hours exposed to SHS. Model included teen age, adult educational attainment, and number of adult smokers in the household.	Reported hours of exposure to SHS in the home in the past week	Full, partial, or no smoking restrictions: Restrictions: None 53% Partial 22% Full 25%	Model-adjusted mean number of hours of SHS exposure was: 33.2 12.7 2.4 ($p<0.001$). Also significant: Number of smokers in household, and in households without smokers, whether visitors smoked	Even with a supposedly smoke-free home, exposure was not zero, indicating incomplete resident/visitor compliance to the smoke-free policy.
Al-Delaimy *et al.*, 2001b Wellington, New Zealand	117 children aged 3 months to 10 years in households with an adult smoker 1996	Wilcoxon ranksum test of log transformed hair nicotine concentration	Hair nicotine concentration	Ban on smoking indoors in households with smokers	Authors reported that distribution of hair nicotine concentrations similar in those with and without a smoke-free policy indoors, but no data given. Other factors examined: Unvariately significant were whether the mother smoked, the father smoked, and the time per week that the child spent away from the home	No multivariate analysis.

Reference/ location	Population/ year data collected	Analysis	Exposure measure(s)	Home smoking restriction variable	Results	Comments
Children in general						
Blackburn *et al.*, 2003 Coventry and Birmingham, England UK	164 households with smokers and bottle fed infants 4 to 24 weeks of age Not reported	Linear regression of log CCR including parent's daily cigarette consumption, partner's daily consumption, housing tenure, overcrowding, and a smoke-free home contrasted to all others	Urinary CCR	No protective measurers used (12%) Some measures used but not a prohibition on smoking inside (69%) Ban on smoking inside (18%) The mean log cotinine to creatinine ratio was 1.26 (range 0.68-1.82) for infants in smoke-free households vs. 2.58 (2.38-2.78) others. No differences in groups using no measures (2.43 [1.83-3.03]) or weak measures (2.61 [2.41-2.81]).	When a smoke-free home was contrasted to all others it was independently significant ($p<0.001$). Also significantly related were parent's daily cigarette consumption ($p<0.001$), and housing tenure ($p=0.003$).	
Johansson *et al.*, 2004 Southeastern Sweden	366 children 2.5-3 years with smoking parents from a population cohort study were compared to a control group of 433 age-matched children with nonsmoking households 1997-99	Logistic regression of < 6 versus ≥ 6 cotinine value in households with smokers	Urine samples were obtained after family approval to participate, but before a detailed survey assessed smokers' behaviour regarding protection of their children from exposure to SHS.	Multi-level variable: Smoke only outdoors with door closed (56%) Smoke outdoors with door open (12%) Smoke by kitchen fan or outside with door closed (14%) Smoke by kitchen fan, outdoors with door closed or by the open door (7%) Take no protective measures (8%)	The odds of a high urinary cotinine level compared to controls were: OR=1.99; 95% CI=1.1-3.6 OR=2.39; 95% CI=0.9-6.1 OR=3.23; 95% CI=1.3-7.9 OR=10.32; 95% CI=4.3-24.8 OR=15.09; 95% CI=6.6-35.3	Logistic regression analysis did not adjust for other factors possibly related to exposure.
Matt *et al.*, 2004 San Diego, California, USA	49 families with infants ≤ 1 year recruited from advertisements Not reported	Tobit regression for data with minimal detectable concentrations	Urinary and hair cotinine and nicotine in hair, as well as nicotine in dust, on surfaces ,and in the air measured at multiple different times	Nonsmoking households contrasted with smoking households where smokers did not smoke inside, or did smoke inside	All exposure measures significantly different in households with smokers with versus without smoking restrictions (see text for details).	No multivariate analysis performed.

Table 8.6 Clinic-based (unless otherwise indicated) studies reporting exposure of children to SHS in homes with and without smoking restrictions

Reference/ location	Population/ year data collected	Analysis	Exposure measure(s)	Home smoking restriction variable	Results	Comments
Children in general						
Groner *et al.*, 2005 Columbus, Ohio, USA	291 children 0-3 years attending pediatric primary care facility 1999-2000	Chi-square tests conducted across groups defined by hair cotinine concentration level	Hair cotinine level : <0.3 ng/mg 0.3-0.7 ng/mg >0.7 ng/mg	A smoke-free home policy present or not	Percentage with policy present 78.6% 54.4% 23.5% p<0.001	The cigarette consumption of the smoking mother was not related to concentration group.
Rise & Lund, 2005 Norway	Mailed questionnaire to random sample of households. Present analysis included children age 3 years with a parent who smokes 1995; 2001	Multiple linear regression of exposure index included household education, attitudes toward SHS, and awareness of SHS risk. Separate analyses for each year.	Index of exposure constructed from parental report of frequency of child exposure to a smoker in a car, TV-room, dining room, elsewhere in the home. The higher the score, the less the child was exposed.	Household had rules about smoking or not	Percentage of households with rules increased from 71% in 1995 to 91% in 2001. In 1995, rules about smoking were more strongly associated with exposure than the other factors in the model, p<0.0001. Rules not significant in 2001.	Rules may have involved less than a smoke-free home
Spencer *et al.*, 2005 Coventry, England, UK	Baseline data for 309 infants 18-30 months in households with smokers from the Coventry Cohort study Not reported	Multiple linear regression of log CCR. Model included mothers' and fathers' average daily cigarette consumption, length of time in home and overcrowding and a smoke-free home contrasted to all others	Urinary CCR	Smoke-free home (13.9%) versus all others	A smoke-free home was found to be significant at the p<0.001 level. Also significant were mothers' average total daily cigarette consumption (p=0.008) and fathers' average total daily consumption (p<0.001). The length of time the family lived in the home and over-crowding, were not significant.	No adjustment was made for demographic variables.
Yousey, 2006 Midwestern, USA	Convenience sample of 202 English speaking and Spanish speaking adult smokers living with a child younger than 6 years of age Not reported	Multivariate logistic regression included number of smokers in home, and potential correlates of a smoking ban (last time someone smoked in home, number of cigarettes smoked in home in last week, other.	Urine cotinine ≤ 30ngdL versus >30 ng/dL.	Smoke-free home versus all others	Even with other variables potentially related to having a completely smoke-free home in the analysis, children living in a smoke-free home had less exposure compared to those in a non-smoke-free home. OR=0.224; 95% CI=0.056-0.902	

Reference/ location	Population/ year data collected	Analysis	Exposure measure(s)	Home smoking restriction variable	Results	Comments
Children in general						
Hughes *et al.*, 2008 Seoul, Korea	207 adult respondents to a population survey living with at least one child under 18 years of age 2002	Multivariate logistic regression adjusted for age, adult smoking, grand-parents smoking, other groups discourage smoking	Adult estimate of number of cigarettes child exposed to in the home in a typical week.	Smoke-free home versus all others	Exposure increased in non-smoke-free households compared to all others. OR=9.13; 95% CI=2.06-40.4	
Wipfli *et al.*, 2008 3 regions: Latin America, Asia, and Europe and the Middle East	1284 households (not randomly selected) from 31 countries with at least one child younger than 11 years 2006	Separate multi-level linear model of each SHS exposure measure for households with male smokers. (See text for variables included).	Hair nicotine levels Air nicotine concentrations	Smoke-free versus all others	Compared to a smoke-free home: Hair nicotine OR=2.6; 95% CI=2.0-3.3 Air nicotine OR=12.9; 95% CI=9.4-17.6 times higher	
Children with asthma						
Winkelstein *et al.*, 1997 Baltimore, Maryland, USA	108 inner city asthmatic children aged 1-19 years attending allergy clinics 1993-94	Analysis of variance of log CCR	Urinary CCR	Households with smokers with a smoke-free home versus Households with smokers with smoking permitted indoors	8.5 ng/mg (median, 5.5 ng/mg) 73 ng/mg (median, 25 ng/mg)	p=0.0005 for log transformed CCR
Wakefield *et al.*, 2000b Adelaide, Australia	249 asthmatic children aged 1 to 11 years with at least one smoking parent attending hospital outpatient clinics 1998-99	Multivariate regression of log CCR. Model also included child's age, mother's smoking status, and total parental daily cigarette consumption.	Urinary CCR	Smoke-free (40.2%) mean CCR: 7.6 nmol/mmol Some exceptions allowed to the policy: (16.5%): 14.9 nmol/mmol Allowed in rooms where child rarely present: (16.8%): 14.1 nmol/mmol No restrictions (26.5%): 26.0 nmol/mmol	In the multivariate regression analysis of the log transformed ratios there was an effect of home restrictions, p<0.001. The type of partial restrictions (visitors, when child absent, cold weather, etc.) did not appear to make a difference. Other significant variables were child's age and total daily household cigarette consumption.	

Table 8.6 Clinic-based (unless otherwise indicated) studies reporting exposure of children to SHS in homes with and without smoking restrictions

Reference/ location	Population/ year data collected	Analysis	Exposure measure(s)	Home smoking restriction variable	Results	Comments
Children with asthma						
Wong *et al.*, 2002 Los Angeles, California, USA	146 asthmatic children (7 years and older) and parent/ guardian pairs from low income homes in which at least one adult smoked. Not reported	Multivariate regression analysis of log urinary cotinine. Independent variables: number of smokers in household, maternal and paternal smoking status, total number of cigarettes per day in the home, number of hours smoked / week by all household smokers in three locations (inside, directly outside the home, in the car), and total number of hours the child was present when smoking in each of these places.	Urinary cotinine	No smoking ever allowed inside versus partial restrictions (some rooms, some circumstances), versus no restrictions on smoking indoors.	In the multivariate analysis, the smoking restriction variable was the most important significant determinant of urinary cotinine level ($p<0.001$), followed by maternal smoking ($p<0.001$) and total number of cigarettes smoked indoors at home ($p<0.001$), and paternal smoking ($p=0.015$). Importance ranked by proportion of variance explained by each factor in univariate analysis.	The authors conclude that only a limited amount of information about smoking in the home is needed to characterise children's SHS exposure.
Berman *et al.*, 2003 Los Angeles, California USA	242 asthmatic children 2-14 years who live in households with smokers identified from schools, clinics and agencies serving low income families 1996-98	Kruskal-Wallis analysis of variance	Parental report of hours exposed, air nicotine concentration, urinary cotinine concentration	Smoke-free (47%): 0.0 hours/week; air 0.01 g/m^3; urine 0.37 ng/ml Partial restrictions (42%): 0.0 hours/week; air 0.06 g/m^3; urine 1.32 ng/ml No restrictions (10%): 5.0 hours/week; air 0.66 g/m^3; urine 2.92 ng/ml	Hours/week ($p<0.001$). Air nicotine concentrations $p<0.001$. Hair nicotine concentrations $p<0.001$.	No multivariate analysis performed. In these California homes, even a partial restriction was linked to a drastically lower exposure.
Wamboldt *et al.*, 2008 USA	91 asthmatic children 6-12 years matched by age, gender, and race/ethnicity to 91 healthy children, all with at least one current smoker in household	Bivariate ANOVA and chi-square analyses	Nicotine dosimeters worn by child and placed in bedroom and family room. Salivary cotinine, self-report by adult of number of cigarettes smoked in presence of child.	Smoke-free home versus all others	Just over 40% of children lived in smoke-free households. All exposure measures were significantly related to reduced exposures in a smoke-free home ($p<0.0001$). No multivariate analysis of exposure conducted.	Main analysis (logistic regression) was to identify predictors of smoke-free homes.

A smoking mother (likely to expose a child more than a smoking father), the total number of smokers in the home, or the total daily cigarette consumption by smokers in the household are all measures that capture the intensity of smoking in the home.

Can interventions aimed at families with smokers reduce children's SHS exposure?

A number of interventions have been designed to increase the protection of children from SHS. Nearly all have focused on getting smoking parents to quit. Although cessation would be best for all concerned, it is difficult to achieve. A later section of this chapter suggests that implementation of a smoke-free home might facilitate cessation in the longer-term, and as the evidence presented above (Table 8.6) indicates, in the shorter-term a smoke-free home will help to minimise children's exposure to SHS.

Family-level interventions

Reviews of trials of interventions at the family level to protect children from SHS include Hovell *et al*., 2000; Hopkins *et al*., 2001; Wewers & Uno, 2002; Gehrman & Hovell, 2003; Roseby *et al*., 2003; Klerman, 2004; and the U.S. Department of Health and Human Services, 2006. The trials were generally of modest scale (<300 families), involved (at a minimum) provision to the intervention group of written educational material about smoking cessation (during pregnancy and for parents of young children), and in some instances, information on the health dangers of smoking in the presence of an infant or child. On the whole, minimal interventions of this kind have not been found to be effective. More intensive interventions have involved brief counseling sessions by a health care provider with or without written materials, and the reviews find little evidence of an impact on childhood exposure to SHS.

Other studies involved multiple clinic-based or in-home counseling sessions, sometimes with follow-up calls or written reminders delivered over months. A few of these more intensive interventions found greater reductions in SHS exposure had occurred among children in the intervention groups compared to controls (Greenberg *et al*., 1994; Groner *et al*., 2000; Hovell *et al*., 2000, 2002; Emmons *et al*., 2001). However, the evidence from biomarkers in the studies that included them was weak. The review articles concluded that fairly intensive interventions are necessary to bring about the desired result in individual households. An editorial commenting on such programs questioned whether they were worth the modest results observed given the effort (Berman, 2003).

It is possible that clinic- or home-based methods aimed at families are too personally intrusive. A somewhat less personal approach used educational materials and one telephone counseling call in the US state of Oregon (Lichtenstein *et al*., 2000; Glasglow *et al*., 2004). Coupons to obtain a radon test kit were sent out in utility bills to 14 000 households. Kits and a brief survey were sent to those returning the coupons (n=1220). From the survey responses, 714 households with smokers were randomised to receive: (1) a copy of the Environmental Protection Agency pamphlet on protection from radon (control group), (2) a copy of a special pamphlet that emphasised that even in low radon households smoking put household members at increased risk of disease, or (3) the special pamphlet and a single telephone counseling call reinforcing the pamphlet by emphasising that smoking cessation or a smoke-free home policy would optimally protect household members. There was a nonsignificant trend for more smoking cessation in the counseling call group compared to the other groups, and this group had significantly more newly implemented home smoke-free policies in place at 12 months follow-up: group 3 -17.2% versus group 1 -14.2% and group 2 -9.9%, $p<0.05$. At baseline, over one-quarter of these households were already smoke-free; Oregon has an ongoing comprehensive tobacco control program.

Population-level interventions

Some of the review articles concerning the clinic- and home-based interventions have suggested that standard population-based tobacco control efforts, including legislation to increase cigarette taxation, include warning labels on cigarette packages, implement advertising restrictions, initiate anti-tobacco media campaigns, and to prohibit smoking in public and workplaces, might reduce the exposure of nonsmokers to SHS simply by reducing population smoking prevalence (Hovell *et al*.,

2000; Wewers & Uno, 2002; Klerman, 2004). Chapter 6 looks specifically at reduction in SHS exposure following new laws restricting smoking. Chapter 7 addresses the implication of smoking restrictions in public places on smoking behaviour, and concludes that comprehensive laws prohibiting smoking in all workplaces reduces smoking; therefore, exposure of nonsmokers to SHS would be reduced.

A review of studies evaluating such policy level options concluded that they might prove to be the most effective option for increasing the prevalence of smoke-free homes (Thomson *et al.*, 2006). This review reported on studies relating greater exposure to tobacco control efforts to a higher prevalence of smoke-free homes. To date, there is no evidence that restricting smoking in public places makes smokers more likely to smoke in their homes (Hyland *et al.*, 2008b), and such policies appear to reduce children's exposure to environmental tobacco smoke overall (Akhtar *et al.*, 2007).

Barriers and triggers for smoke-free homes

Several qualitative studies have examined what messages might best encourage smokers to adopt smoke-free policies at home or how such policies had been adopted (Gupta & Dwyer, 2001; Kegler *et al.*, 2007; Robinson & Kirkcaldy, 2007; Escoffery *et al.*, 2008). Results from one study suggested that themes emphasising child health, but at the same time respecting smokers, might be effective (Gupta & Dwyer, 2001). Language should not be patronising and should encourage smokers not to smoke rather than criticising them for smoking. Messages should not make smokers feel guilty or imply a criticism of bad parenting. Participants preferred the slogan "welcome to a smoke-free home" to the slogan "our home is smoke-free because we care." One study found that it was almost always a female caregiver that broached the subject of adopting a smoke-free home, usually a nonsmoker, and at least half the time this person was also the one in the family seen as having the power to do it (Kegler *et al.*, 2007). Triggers for adopting a smoke-free home included a new baby, a move to a new home, someone moving in or out, physician recommendation, or a health problem of a household member. Reasons for adopting a smoke-free home centered on protecting children, but also included aversion to smoke by adults and children, as well as the smell of cigarettes permeating the household. Whether smoke-free home policies would be lifted after children grow up and leave home is a matter for further research. Participants generally believed that allowing or not allowing smoking in the home was a private matter.

In 2004, focus groups in the UK, with 54 disadvantaged smoking mothers of children 0-4 years of age, revealed not all mothers understood the dangers of SHS to their children (Robinson & Kirkcaldy, 2007), and that knowledge did not necessarily mean the mother took steps to protect her children. Nearly all mothers agreed that they never would smoke in their child's bedroom. While some indicated that no smoking was allowed inside their homes, they went on to describe significant exceptions, such as smoking only in the bathroom or kitchen with the door closed and window open, or smoking inside at night if they felt unsafe going outside. Many mothers smoked in the doorway or outside, but noted that their small children tended to follow them and so were exposed anyway. Some tried to smoke only when the child was not present in a particular room, but wondered whether the smoke lingered or dispersed into adjacent rooms. Small homes limited the distance mothers could maintain between themselves and their children when they smoked. Often attempts to limit their children's exposure were transitory, because the mother did not believe her efforts were making a difference. How to overcome these barriers for disadvantaged families remains a subject for further research.

Another study conducted interviews with adults in 102 households with smokers and with young adolescent children in rural areas of the US state of Georgia (Escoffery *et al.*, 2008). Thirty-five (34%) of these households had a smoke-free home, 55 (54%) had partial restrictions, and 12 (12%) no restrictions. Enforcement of a smoke-free policy was problematic for about a third of the households; visitors and bad weather accounted for most of the infractions. Those without a smoke-free policy might consider implementing one if someone, particularly a child, became ill. Smokers in households with a smoke-free policy or partial restrictions discussed their family's desire that they quit. Ideas for

implementing a completely smoke-free home included putting up signs indicating the home was smoke-free, getting rid of ashtrays, and creating a place outside for smoking. The author supported these ideas of ways to create and maintain smoke-free households.

While some attention has been devoted to the idea of legislation making it illegal to smoke in homes and cars with children (Ezra, 1994; Ashley & Ferrence, 1998), it is unlikely that such laws affecting homes will become widespread. In the USA, such a law would be unconstitutional, but this may not be the case in other countries. Perhaps enforcement of such a law would involve too great an invasion of privacy, superseding a public obligation to protect the health of children. However, enforcement of a law prohibiting smoking in cars in which children are passengers may be no more difficult than enforcement of laws regarding seatbelt use. There appears to be substantial popular support for a law prohibiting smoking in cars when children are present in many localities, including in a number of US states (see Chapter 6).

A recent study examined how families establish and enforce smoking rules in family cars (Kegler *et al*., 2008). Like the Escoffery *et al.* (2008) study described above, this study summarised findings from interviews of 136 Black and White families in rural Georgia. Just under half (46.3%) of the families had a smoker. Fewer than half the families had ever discussed car smoking rules, but 36.8% reported a smoke-free car rule, 40.4% partial restrictions, and 22.8% reported no rules against smoking in the car. Reasons stated for having a smoke-free car included protecting nonsmoking passengers from SHS, that the closed in nature of a car makes smoke stifling, the smell of smoke, and not wanting damage to the car from burns or smoke. Besides prohibiting smoking, respondents suggested only smoking with the windows open or when nonsmokers (including children) were not present. Families with rules generally had some difficulty enforcing them. Smokers were agreeable at least half the time they were asked not to smoke, but a few were resentful. Participants without a smoke-free policy indicated that they might consider adopting one if the smoker(s) in the family quit or the family got a new car.

Summary

In localities with relatively high adult smoking prevalence, protecting children and youth from exposure to SHS remains problematic. Often the reported prevalence of exposure to SHS and parental smoking prevalence are similar. In some localities, there have been marked increases in the fraction of children protected from SHS smoke in the home; these trends are more rapid than what would be expected to result from a decline in population smoking prevalence. These locales tend to be places where there are laws prohibiting smoking in public and workplaces. Increased awareness of the dangers of SHS, resulting from passage and implementation of these laws, might influence people to adopt such rules for their homes as well.

Observational studies show that children are less exposed to SHS in households in which smoking is restricted than in those allowing smoking inside. A smoke-free home policy appears to provide greater protection than partial restrictions. Even then, protection may not be complete because of breaches in compliance and exposure of children to SHS in settings outside the home. In multivariate analyses relating exposure of children to SHS to smoking habits of adults, besides the presence of smoking restrictions, some measure of the intensity of smoking in the home is an important correlate.

Home smoking policies appear to be more prevalent in homes with children or other nonsmokers, among those of higher socioeconomic status or education, among those who believe that SHS is dangerous, among younger smokers and in some ethnic groups (for instance, in the USA, smoking in the home is less common among Hispanics and Asians). Women smokers, perhaps mostly stay-at-home mothers, appear less likely to have a smoke-free home because they spend so much of their time there. Smokers interested in quitting or who have made a quit attempt also may be more likely to have smoke-free homes.

Increasing the number of smoke-free homes in general is an important public health goal, but only a very small minority of trials designed to protect children from SHS have shown positive results. These trials have tended to focus more on parental smoking cessation than promoting smoke-free homes. Bringing about behaviour change on an individual level has proved difficult.

Laws prohibiting smoking in public settings and workplaces may

prove to be the most effective way to stimulate adoption of such polices in the home. Such laws both establish and reinforce a population norm that smoking around nonsmokers is unacceptable. Smokers tend to increase their support for such smoke-free laws after they are implemented (see Chapter 5), and as a result, may extend such policies voluntarily to their homes. Other common tobacco control measures might also reinforce population norms against smoking.

Smoke-free home effect on smoking behaviour

There have been no previous reviews of studies addressing the potential effect of home smoking restrictions on adult or youth smoking behaviour. For this reason, all, rather than only selected studies located in the literature on this topic, are described below. First, there is a discussion of how smoking restrictions in the home might alter smokers' smoking behaviour, leading them to smoke less and perhaps eventually quit. This section also addresses the effect home smoking restrictions have on smoking uptake among adolescents.

Whereas smoke-free workplaces are generally imposed by law or by an employer, smoking restrictions in the home generally need to be by agreement among household adults. Often a nonsmoking adult in the household will negotiate a smoking policy to protect themselves and/or children in the household from exposure to SHS. However, even in a household where all adults smoke, residents may agree that not smoking inside is important for the health of their children. In households without children where all adults smoke, residents may want to maintain a home free of stale cigarette smoke and that is inviting to their nonsmoking relatives and friends.

The studies described below involve data from population surveys and are subject to the limitations inherent in the resultant data. Smoking behaviour and information on smoking restrictions are by self-report. In general, biochemical validation, or validation by report from a significant other, have indicated self-report to be reliable (Hatziandreu *et al*., 1989; Gilpin *et al*., 1994).

Effect on adults

Why home smoking restrictions might affect adult smoking behaviour

Having a smoke-free home may be a sign of a smoker's motivation to quit or it may lead to an increase in a smoker's level of motivation to quit. Some smokers may initially agree to the imposition of a smoke-free home policy because of pressure from nonsmokers in the household to protect the health of family members and to eliminate annoyance and odor from tobacco smoke in the home. However, for such smokers, the barriers to smoking intrinsic in having a smoke-free home may also lead to changes in smoking behaviour that increase the chances for future successful cessation.

For many moderate to heavy smokers, the most important cigarette is the first one in the morning (after a night without nicotine). A sizable majority of these smokers have their first cigarette within the first half-hour of awakening, which is one of the main indicators of nicotine addiction (Fagerstrom & Schneider, 1989). Smokers with smoke-free homes must cope with the inconvenience of going outside soon after awakening or postponing their first cigarette. A smoke-free home also creates a barrier to other cigarettes, such as the one after a meal. Thus, the smoke-free home policy may disrupt some psychologically addictive behaviour patterns commonly cited as the most difficult situations in which to avoid smoking (Best & Hakstian, 1978; U.S. Department of Health and Human Services, 1988; Payne *et al*., 1996; Shiffman *et al*., 1996; Drobes & Tiffany, 1997). Eventually, because of these barrier-induced behavioural changes, smokers may smoke less, thereby lessening their addiction, and have increased self-efficacy with respect to managing their smoking behaviour. Together with the inconvenience of having to go outside to smoke, these factors may increase the smoker's motivation to quit. In fact, having a smoke-free home has been associated with higher smoking abstinence, self-efficacy, and motivation to quit (Berg, *et al*., 2006; Shields, 2007).

Once quit, a smoke-free home may be effective in preventing relapse. Especially when there is another smoker in the household, a smoke-free home can reduce smoking temptations; quitters will not have to witness people smoking in their immediate environment, which can induce cravings in recent ex-smokers (Mermelstein *et al*., 1983; Coppotelli & Orleans, 1985; Horwitz *et al*., 1985; Brownell *et al*., 1986; Marlatt *et al*., 1988; Garvey *et al*., 1992).

To the extent that smoke-free homes can lead to reduced nicotine addiction and encourage and prolong quit attempts, they will likely foster eventual successful cessation (Farkas *et al.*, 1996; Pierce *et al.*, 1998d). However, reduced cigarette consumption does not always translate to reduced addiction. Some smokers may maintain their accustomed nicotine levels by increasing the number of puffs they take from each cigarette they smoke or inhaling more deeply (McMorrow & Foxx, 1983; Scherer, 1999). To the extent that smokers derive more from each cigarette they smoke, the potential to diminish addiction is less. A recent study compared reducers to habitual light smokers (Hatsukami *et al.*, 2006). Both groups smoked on average the same number of CPD (5-6). However, the levels of toxins in the reducers' blood was about 20% higher than measured in the blood of the habitual light smokers. Further, the variability of toxin level in the reducers was much greater than for the habitual light smokers, indicating that while some managed to reduce their addiction level by reducing their consumption, others likely had maintained it.

Results for studies examining the effect of home smoking restrictions on adult smoking behaviour

The published findings summarised in Table 8.7 and presented in detail in Appendix 6 all show some relationship between home smoking policies and characteristic(s) of adult smoking behaviour. Whether studies investigating this topic that failed to find such an effect were not submitted or not accepted for publication is unknown.

Seven of these studies were longitudinal and all showed reduced relapse, increased quitting, or progress toward cessation by follow-up for smokers living in a smoke-free home compared to those without such a policy or no policy. In the five studies that examined consumption among continuing smokers, all but one noted a decline for those in smoke-free homes that was greater than that observed among those not living in a smoke-free home. The exception (Hyland *et al.*, 2009) found a significant effect if baseline consumption was not included in the model. Several of the other studies included this variable, but still found an effect (Shields, 2005, 2007; Messer *et al.*, 2008a).

The other studies were all cross-sectional, so that while it is possible to demonstrate a relationship, the direction is not clear. Do people who modify their smoking behaviour institute home smoking rules to help them maintain their changes, or do such restrictions lead to modifications in smoking behaviour, including quitting? Again, among the cross-sectional studies that examined the relationship between home smoking restrictions and cessation and/or cigarette consumption, such a relation was found in all but one (Norman *et al.*, 2000). It should be noted that many of the researchers examined the same surveys, although perhaps in different years: three looked at the California Tobacco Surveys, seven the Current Population Surveys, and two Canadian national surveys. It would be expected, therefore, that the results would be concordant because the same survey instruments were used in the same locales. However, as the prevalence of smoke-free homes increases, it is possible that the strength of the association may change (Shopland *et al.*, 2006; Pierce *et al.*, 2009). A number of these studies examined workplace smoking policies, as well as home smoking restrictions (Pierce *et al.*, 1998c, Farkas *et al.*, 1999; Gilpin *et al.*, 2000; Gilpin & Pierce, 2002b; Shavers *et al.*, 2006; Shopland *et al.*, 2006; Burns *et al.*, 2007; Shields, 2005, 2007; Lee & Kahende, 2007; Messer *et al.*, 2008b). These studies are also included in Chapter 7, but only the results regarding workplace policies are discussed. The present chapter presents both the results for home and workplace smoking restrictions.

Longitudinal. The earliest longitudinal study investigating the effect of home smoking restrictions was from California. Although home and work area smoking restrictions and having cessation assistance were only assessed at follow-up, this study (n=1736) related these factors to changes in smoking behaviour over an average 18-month period between 1990 and 1992 (Pierce *et al.*, 1998c). The outcome variable was advancement along a quitting continuum (high addiction and no quitting history, low addiction or quitting history, and low addiction and quitting history, or being quit at least three months at follow-up). Beliefs in the harmfulness of SHS were factored into the home smoking rule variable as an intermediate level: no beliefs and no rules, beliefs, a smoke-free smoking home policy; almost no one with such a policy believed SHS was not harmful.

Table 8.7 Summary of results of studies examining the relationship between home smoking restrictions and *adult* smoking behaviour

		Outcomes					
				Cessation			
Reference	**Locality**	**Prevalence**	**Consumption**	**Quit attempt**	**Quit-any duration**	**Reduced relapse**	**Other**
Longitudinal							
Pierce *et al.*, 1998b	California, USA						SIG-progress toward cessation
Pizacani *et al.*, 2004	Oregon, USA			SIG	SIG	SIG	
Shields *et al.*, 2005	Canada		SIG*		NS	SIG	
Borland *et al.*, 2006a	Australia, Canada, UK,USA		SIG	NS	SIG		
Shields *et al.*, 2007	Canada		SIG		SIG		
Messer *et al.*, 2008a	USA		SIG		SIG		
Hyland *et al.*, 2009	USA		NS**	SIG	SIG	SIG	
Cross-sectional							
Farkas *et al.*, 1999	USA		SIG	SIG	SIG		
Gilpin *et al.*, 1999	California, USA		SIG	SIG		SIG	SIG-intent to quit
Gilpin *et al.*, 2000	USA	SIG	SIG				
Norman *et al.*, 2000	California, USA		SIG	NS			SIG-desire to quit
Gilpin & Pierce, 2002b	California, USA		SIG				
Siahpush *et al.*, 2003	Australia				SIG		
Shavers *et al.*, 2006	USA	SIG	SIG	SIG			
Shopland *et al.*, 2006	USA				SIG		
Gilpin *et al.*, 2006	California, USA					SIG	
Lee & Kahende, 2007	USA				SIG		
Burns *et al.*, 2007	Colorado, USA						SIG-duration of smoking
Ji *et al.*, 2008	California, USA				SIG		
Shelley *et al.*, 2008	New York City, USA		SIG	SIG			
Messer *et al.*, 2008b	USA			SIG	SIG		
Tong *et al.*, 2008	California, USA		SIG		SIG		
Pierce *et al.*, 2009	USA		SIG				

SIG = significant difference in smoking behaviour indicated between smokers with and without home smoking restrictions. All significant differences were in the direction of reduced smoking (i.e. less consumption, more quitting) in homes with restrictions.
NS = No significant difference
No entry means that the outcome was not considered
*Cross-sectional analysis of baseline data
**SIG in model without baseline level of addiction

Analyses controlled for demographics. A smoke-free home was significantly associated with advancement along the quitting continuum (OR=3.4; 95% CI=1.9-5.9), but simply a belief in the harmfulness of SHS was not (OR=1.3; 95% CI=0.7-2.2). No smoking in the work area (OR=1.6; 95% CI=1.0-2.6) and having cessation assistance (OR=3.0; 95% CI=1.7-5.3) were also associated with progress; a work area policy less so than a smoke-free home policy. A further analysis showed that 41% of smokers with two or three of these factors progressed toward cessation, compared to 23% with just one and 13% with none. When the smoke-free home and workplace policies were established relative to the smoker making progress toward cessation was unknown.

The relationship between home smoking restrictions and relapse following a quit attempt, was examined using longitudinal data from a 1997 survey which identified smokers, their readiness to quit (pre-contemplation, contemplation, or preparation), and whether or not their home had no or partial restrictions or was completely smoke-free (Pizacani *et al.*, 2004). In 1999, a follow-up survey of 565 baseline smokers (52%) assessed quitting and duration of abstinence for those who had quit in the interim. Smokers with a smoke-free home were 2 times more likely (OR=2.0; 95% CI=1.0-3.9) to have made a quit attempt lasting a day or longer. This study showed that for smokers preparing to quit (in the next 30 days) at baseline, the presence of a smoke-free home both predicted a future quit attempt and prolonged the period of abstinence for that attempt, compared to those with only partial or no restriction on smoking in the home; the odds were 4.4 (95% CI=1.1-18.7) of being off cigarettes at least a week when interviewed at follow-up. Relapse curves for these two groups were significantly different ($p<0.02$). For smokers not preparing to quit, but who nevertheless did make an attempt prior to follow-up, relapse curves for those with no or partial compared to a smoke-free policy were the same. While not formally analysed, baseline smoking intensity appeared to be related to having a smoke-free home versus partial or no smoking restrictions.

A series of Canadian longitudinal studies at two year intervals from 1994-95 to 2001-02 assessed, with combined data, the effects of both smoke-free homes and workplaces at baseline among daily smokers and continuous cessation initiated within two years prior to the follow-up period (Shields, 2005); follow-up exceeded 80%. Working in a smoke-free environment was not associated with quitting. Having a smoke-free home was related to indicators of addiction level, and this factor was significant bivariately in both men and women (men: OR=1.4; 95% CI=1.0-1.9, and women: OR=1.5; 95% CI=1.1-2.1). Yet in a multivariate analysis that controlled for demographics and addiction variables, it failed to reach statistical significance (men: OR=1.1; 95% CI=0.8-1.6, and women: OR=1.3; 95% CI=1.0-1.9). However, among former smokers at baseline, having a smoke-free home was significantly related to maintenance of abstinence multivariately for men (OR=0.6; 95% CI=0.4-0.9), but not for women (OR=1.0; 95% CI=0.6-1.6). A cross-sectional analysis of 2003 data indicated that those living in a smoke-free environment smoked five fewer CPD ($p<0.05$). A combination of having both a smoke-free workplace and a smoke-free home was associated with an even greater difference in consumption, seven and six fewer CPD for men and women, respectively ($p<0.05$), compared to those working and living in environments where smoking is permitted.

A subsequent longitudinal analysis of these Canadian data (Shields, 2007) looked at the effect of newly imposed smoking restrictions both at work and in the home. Separate analyses were conducted for workplace and home restrictions over multiple survey waves from 1994 to 2005. Follow-up was 77% at the final wave analysed. The workplace analysis considered 1364 smokers age 15 years and older employed in one wave at a workplace where smoking was not restricted, and in a subsequent wave where it was restricted, and evaluated behaviour in the following (two years later) wave after the restriction was imposed. A similar combination of data from various survey waves identified 8463 smokers age 15 years and older subject to new smoking restrictions in the home. To evaluate the effect of newly imposed workplace restrictions, a multivariate analysis adjusted for cigarette consumption at baseline, sex, age, education, income, and occupation (white-collar, sales/service, and blue collar). Smokers working under a newly imposed smoke-free policy were 2.3 (95% CI=1.4-3.9) times more likely to be quit at follow-up (27%) than those

working continuously where there was not a smoke-free policy (13%). The definition of quitting was report of smoking "not at all" at follow-up with no time criterion. Partial restrictions were not related to increased quitting. Daily smokers who did not quit but who worked under a new smoke-free policy reduced their cigarette consumption by 2.1 CPD; there was no change in consumption for those who continued to work in a workplace with no smoking restrictions. For the analysis of new home restrictions, the multivariate analysis substituted the presence of children for occupation and considered only a smoke-free home versus a home with no restrictions. Smokers living in a newly smoke-free home were 1.6 (95% CI=1.3-2.1) times more likely to be quit at the follow-up wave. Daily smokers who continued to smoke tended to decrease their consumption and averaged 2.0 CPD less at follow-up compared to 0.4 CPD less among those without new smoke-free home policies.

Another longitudinal study examined data from subsequent waves of the International Tobacco Control Four Country Survey (Borland *et al.*, 2006a). The countries studied were Canada, the USA, the UK, and Australia; data were from 6754 respondents to the baseline survey in 2002, and the second wave conducted six to 10 months later (75% follow-up). At baseline, a smoke-free home was associated with both lower mean daily cigarette consumption and longer duration to the first cigarette after awakening in the morning. Implementing a smoke-free home policy between survey waves was associated with favorable changes in both these factors ($p<0.001$). Compared to homes with no smoking restrictions, a smoke-free home was also associated with increased quit attempts (OR=1.32; 95% CI=1.11-1.57) and being abstinent for one month or longer at follow-up (OR=2.50; 95% CI=1.50-4.16), after adjusting for: demographic factors, the presence of smokers in the household, belief in the harmfulness of SHS, a social norm variable, and report of restrictions in other venues frequented (bars, restaurants, and workplaces). However, when an index of baseline addiction level and other predictors of cessation were included in the multivariate model, the smoke-free home effect for making a quit attempt was no longer significant. Yet, when duration of abstinence (at least a month) was analysed among those who made a quit attempt, even after controlling for addiction and all the other variables, having a smoke-free home, but not partial restrictions predicted the outcome (OR=2.07; 95% CI=1.20-3.56).

A recent further analysis of the Community Intervention Trial for Smoking Cessation (COMMIT) longitudinal data looked specifically at the effect of a smoke-free home policy at baseline related to changes in smoking behaviour (Hyland *et al.*, 2009). There were 4963 smokers at baseline in 1988 who were interviewed again in 2001 and 2005. The latter two surveys asked about smoking restrictions in the participants' homes. The percentage of smokers in 2001 who reported a smoke-free home was 29%, and this increased to 38% by 2005. In logistic regression analyses that adjusted for age, sex, race/ethnicity, annual household income (2001), education (1988), and number of cigarettes smoked (2001), smokers with a smoke-free home in 2001 were 1.7 (95% CI=1.4-2.2) times more likely to be quit at follow-up than those without such policies. If not quit in 2005, they were 1.5 (95% CI=1.3-1.9) times more likely to have made a serious attempt to quit in the interim. However, there was no significant effect for a smoke-free home policy on consumption in continuing smokers. Among those quit in 2001, having a smoke-free home helped them remain quit; they were only 0.6 times (95% CI=0.4-0.8) as likely to relapse as those without such a policy.

A final longitudinal study used data collected twice (one year apart) from the national Current Population Survey in the USA (Messer *et al.*, 2008b). In this analysis of 3292 recent smokers, 28.4% had a smoke-free home at baseline in 2002, and among those who did not, 20% had adopted one by follow-up in 2003. The study examined cessation at follow-up, cessation for at least 90 days at follow-up, and cigarette consumption among continuing smokers. Multiple logistic regression analyses adjusted for age, sex, race/ethnicity, incomes below two times the poverty level, the presence of another smoker in the household, and cigarette consumption at baseline in 2002. Having a smoke-free home (versus all others) at baseline was predictive of increased quitting by follow-up: quit, OR=1.52; 95% CI=1.08-2.15, $p<0.05$, and quit 90+ days, OR=1.44; 95% CI=0.97-2.21, $p<0.10$. However, adoption of a smoke-free home by 2003 was highly predictive of increased quitting: quit, OR=3.89;

95% CI=2.55-5.87, and quit 90+days, OR=4.81; 95% CI=3.06-7.59. Among continuing smokers who adopted a smoke-free home, a multivariate analysis showed that consumption declined by 2.18 (95% CI=1.24-3.10) CPD compared to those who did not. Removal of a smoke-free home policy was associated with increased smoking compared to maintenance of a smoke-free home policy. It is possible that smokers adopted a smoke-free home simultaneously with their attempt to quit, and removed it when they relapsed. Nevertheless, adoption of a smoke-free home appeared to increase the chances of success markedly.

Cross-Sectional. A study which proposed an index of initial outcomes from tobacco control policies for US states included as components: the price of cigarettes, the percentage of indoor workers reporting smoke-free workplaces, and the percentage of the population reporting smoke-free homes (Gilpin *et al.*, 2000). Data concerning smoke-free homes and workplaces were from 237 733 self-respondents to the 1992-93 Current Population Survey (CPS); cigarette price data were from sales data reported to the Federal Trade Commission. The smoke-free home component correlated better among the US states (51, including the District of Columbia) with adult (r= -0.66, p<0.001) and youth smoking prevalence (r=-0.39, p<0.01) than the other two components. In fact, correlations for the composite index with these outcomes were r=-0.70 (p<0.0001) and -0.34 (p<0.05), suggesting that the other components of the index added little to explaining prevalence. However, for per capita cigarette consumption, the correlation of adult smoking prevalence with the initial outcome index, r=-0.73 (p<0.0001), was only slightly higher than for cigarette prices, r=-0.71 (p<0.0001), and much higher than for smoke-free homes, r=-0.58 (p<0.0001), and smoke-free workplaces, r=-0.54, p<0.001. While these correlational results cannot demonstrate causality, they are suggestive that smoke-free homes are at least an indication of societal norms against smoking.

The relationship between work and home smoking restrictions and quitting behaviour was also analysed using the 1992-93 CPS data (n=48 584 smokers in the last year) (Farkas *et al.*, 1999). Variables analysed included making a quit attempt on at least one day or longer in the past year, cessation of at least six months when interviewed, and light smoking (<15 CPD). In multivariate logistic analyses that included age, sex, race/ethnicity, education, income, occupation, region, age of youngest child in household, and social factors (lives with a smoker, a former smoker, or a never smoker), compared to having no smoking restrictions, home smoking restrictions were significantly related to making a quit attempt (partial: OR=1.83; 95% CI=1.72-1.93, smoke-free: OR=3.86; 95% CI=3.57-4.18), cessation for at least six months (partial: OR=1.20; 95% CI=1.05-1.38, smoke-free: OR=1.65; 95% CI=1.43-1.91), and light smoking (partial: OR=1.81; 95% CI=1.69-1.95, smoke-free: OR=2.73; 95% CI=2.46-3.04). A partial home restriction was generally more related than a partial workplace restriction (quit attempt: OR=1.14; 95% CI=1.05-1.24, six months cessation: OR=1.21; 95% CI=1.00-1.45, light smoking: OR=1.53; 95% CI=1.38-1.70), contrasted to no workplace smoking restrictions. In contrast to a completely smoke-free workplace, smoke-free work areas were not significantly related to the smoking behaviour outcomes examined.

Another analysis of CPS data from 1998-99 and 2001-02, examined the effect of workplace and home smoking restrictions on current smoking, cigarette consumption, and quit attempts in employed women (n=82 996) (Shavers *et al.*, 2006). Analyses were stratified by poverty level and race/ethnicity and adjusted for age, education, marital status, and occupation. Regardless of whether separate analyses considered women of each race/ethnicity or of similar poverty level, compared to having no restrictions, partial or no home smoking restrictions were associated with being a current smoker (adjusted odds ratios ranged from 11.1 to 28.8 for no restrictions, and from 3.8 to 11.2 for partial restrictions). The association was weaker among Native Americans (including Alaskan natives) than for other groups; it appeared strongest for African Americans. Workplace smoking restrictions showed little relation to current smoking. Among current smokers, having a smoke-free work area was significantly associated with less heavy smoking (20+ CPD) for some poverty groups but not others. Also, not having home restrictions was even more related (odds ratios ranged from 3.4 to 6.2 for completely smoke-free policy and

from 1.4 to 2.9 for partial restrictions). Workplace smoking restrictions were not related to making a quit attempt, but no smoking restrictions in the home was significantly and inversely related to making a quit attempt in the last year (odds ratios ranged from 0.43 to 0.69).

Yet another study used data from the CPS to examine the determinants of smoking cessation among employed female daily smokers (one year before survey) age 25 years or older who did not live alone (Shopland *et al*., 2006). The sample sizes of women meeting these criteria were not reported, but the data were from the 1992-93 and 2001-02 CPS, which included a total of 128 024 employed women age 18 years and older. Smoking status one year prior to the survey was by retrospective recall. Two measures of cessation were considered: not smoking at all at the time of the survey, and quit for at least three months when interviewed. Factors examined for association with quitting included home smoking restrictions (no restrictions, partial restrictions, home smoke-free), age, education, race/ethnicity, workplace smoking restrictions (permitted versus not permitted), occupation, the presence of young children in the household (no children under 5 years versus children under 5 years), and household composition (multiple adults, no children, multiple adults and children, one adult and children). Separate analyses were performed for each quitting measure and for the 1992-93 data and the 2001-02 data. The percentage of all current smokers (employed females age 18 years and older) at the time of the survey reporting a smoke-free home increased from 5.5% (95% CI=4.8-6.2) in 1992-93 to 22.0% (95% CI=20.4-23.5) in 2001-02. For both surveys and both measures of quitting, home smoking restrictions were the factors most strongly associated with cessation. In 1992-93, daily smokers a year previously were 7.77 (95% CI=5.91-10.21) times more likely to be quit, and those living under partial restrictions were 2.15 (95% CI=1.70-2.73) times more likely to be quit compared to those living where there was no restrictions. Similarly, in 2001-02, these adjusted odds ratios were 6.54 (95% CI=4.61-9.28) and 2.34 (95% CI=1.54-3.55), respectively. Only a few other factors were significant. There was no association with this outcome for smoke-free workplaces in either year. When cessation for at least three months was the dependent variable, again home smoking restrictions were highly related in both years: smoke-free, OR=7.41 (95% CI=5.55-9.90), and partial restrictions OR=2.18 (95% CI=1.63-2.92) in 1992-93; and smoke-free, OR=7.08 (95% CI=4.45-11.26) and partial restrictions OR=2.45 (95% CI=1.48-4.07) in 2001-2002. In 1992-93, a smoke-free workplace was directly related to cessation for at least three months ($p<0.03$).

Data on 8904 current smokers from the 1996 California Tobacco Survey were used to examine quit attempts in the last year, intent to quit in the next six months, light smoking (<15 CPD), smoking the first cigarette of the day within 30 minutes of awakening, and the duration of the longest quit attempt in the past year (Gilpin *et al*., 1999). The multivariate logistic regressions included demographic factors, household composition (other smoker, children), belief in the harmfulness of SHS, and a family preference that the smoker not smoke. A belief in the harmfulness of SHS was significantly related to the three main dependent variables analysed (quit attempt, intention to quit, light smoking). Compared to no family preference and no restrictions, with a family preference that the smoker not smoke, a smoke-free home was related to all three outcomes (quit attempt: OR=3.9 (95% CI=3.0-5.2), intent: OR=5.8 (95% CI=3.8-8.2), light smoking: OR=2.2 (95% CI=1.2-3.0), and partial restrictions to making a quit attempt OR=2.7 (95% CI=2.0-3.6), and intent to quit: OR=3.7 (95% CI=2.7-5.1)), but not to being a light smoker: OR=1.1 (95% CI=0.8-1.5). Quitters living in smoke-free homes appeared to maintain their abstinence significantly longer than those with no or only partial home smoking restrictions; the latter two groups showed about the same relapse pattern. The percentage of light daily smokers delaying their first cigarette for at least 30 minutes after awakening was 89% in smoke-free homes and 82% in homes with no restrictions. For moderate to heavy smokers, these percentages were 64% and 47%, respectively. Smoke-free homes appeared to have a greater effect on moderate to heavy smokers than on light smokers.

Another analysis of data from the 1999 California Tobacco Survey focused on daily cigarette consumption (Gilpin & Pierce, 2002b). In a multivariate linear regression that adjusted for demographics, and included both having a smoke-free

home and smoke-free workplace, both factors were significant (smoke-free homes, $p<0.0001$; smoke-free workplace, $p<0.05$). The estimated least-squares estimates for mean daily consumption for smokers living in smoke-free households was 8.0 CPD, compared to 11.1 CPD for those without smoke-free policies. The analogous results for workplaces were 9.4 versus 11.1 CPD. A further analysis computed the least-squares daily consumption means for smokers with no policies for a smoke-free home or workplace (13.9 CPD), a smoke-free workplace only (11.1 CPD), a smoke-free home only (9.4 CPD), and both types of these policies (7.5 CPD).

Data from the 1999 and 2002 California Tobacco Survey were combined to examine duration of abstinence for the most recent quit attempt in the past year (n=2640 quitters who smoked at least 15 CPD a year previously) for smoke-free home policies, in conjunction with having other smokers in the home, and the use of pharmaceutical aids (nicotine gum, patch, or bupropion) for smoking cessation (Gilpin *et al*., 2006). Cox proportional hazard analyses adjusted for age, sex, race/ethnicity, education, and daily cigarette consumption. There were significant interaction effects (less relapse) for a smoke-free home and no other smoker in the home (hazard ratio: 0.796 (95% CI=0.645-0.988)), and a smoke-free home and use of a pharmaceutical aid (hazard ratio: 0.774 (95% CI=0.622-0.963)). Abstinence duration was shorter if there was another smoker present in the household regardless of home smoking policy or pharmaceutical aid use. Without a smoke-free home, pharmaceutical aids did not appear to prolong duration of abstinence. With a smoke-free home, and no other smoker in the home, pharmaceutical aids appeared to be most effective in prolonging abstinence. Because of small sample size, the results for aid use, when another smoker was present in a smoke-free home, were less clear, but aid users seemed to remain abstinent longer. It is possible that having a smoke-free home, or instituting one following a quit attempt, is an indication of the quitter's motivation to remain abstinent.

Another California survey from 1998 was used to examine 1315 smokers age 25 years and older for a relationship between smoke-free homes and daily cigarette consumption, days smoked in the past month, desire to quit, and making a quit attempt in the past year (Norman *et al*., 2000). Multivariate models adjusted for age, sex, education, race/ethnicity, and the presence of children in the home. A smoke-free home was related to lower cigarette consumption ($p<0.01$) and a desire to quit smoking (OR=2.9; 95% CI=1.8-4.9), but not to days smoked in the last month or making a quit attempt in the past year. Smokers living in a household with rules against smoking were about twice as likely (OR=2.29; 95% CI=1.22-4.29) to have reported hearing about community programs to discourage smoking and nearly three times (OR=3.18; 95% CI=1.34-7.57) as likely to report seeing and talking about anti-tobacco media spots.

A study of success in quitting (for at least one month) among recent quitters (attempts in the past two years) considered a number of potential social/environmental influences, including home smoking rules (Siahpush *et al*., 2003). This study examined 2526 Australian smokers aged 14 years and older. In addition to demographics (sex, age, marital status, dependent child, education, occupation, and urban versus rural), it considered children in the home, belief in the harmfulness of SHS, having friends who smoke, smoking restrictions at work or school (none, some, total, not applicable), and alcohol consumption. In the adjusted model, having a smoke-free home increased the odds of cessation by 4.5 (95% CI=3.1-6.6) over having no restrictions. Workplace or school restrictions were unrelated to quitting success in this study.

A similar study contrasted unsuccessful quitters with those who had remained continuously abstinent for seven to 24 months (Lee & Kahende, 2007). Data were from 3990 quitters responding to the 2000 National Health Interview Survey. As a measure of smoking rules in the home, the survey asked how many times anyone had smoked anywhere in the home in the last week, and those answering zero were contrasted to all others. Those who worked in a smoke-free workplace were also contrasted to all others. The logistic regression analysis adjusted for age, education, marital status, race/ethnicity, number of lifetime quit attempts, and whether the smoker had ever switched to low tar/nicotine cigarettes. The adjusted odds ratio for no smoking in the home was 10.47 (95% CI=8.15-13.46) and for a smoke-free workplace it was 2.01 (95% CI=1.20-3.37).

Ever smokers of Korean descent (n=2830) were identified from a large telephone survey in California (Ji *et al.*, 2005). Those quit for at least 90 days were contrasted to all others in a multivariate logistic regression analysis that included gender, education, family income, acculturation, number of smokers among family and friends, social network among family and friends, media influence, job satisfaction, health belief scale, health concern, body mass index, weight concern, exercise, family history of respiratory illness, and medical treatment for respiratory illness, as well as a variable for the extent of smoking restrictions in the home. This variable was coded into five categories: 1) no one allowed to smoke inside, 2) special guests allowed to smoke inside, 3) smoking allowed in certain areas, 4) smoking allowed anywhere, and 5) those not responding to the question. Compared to those with a smoke-free home, those with designated areas inside were less likely (OR= 0.17; 95% CI=0.12-0.24) to be former smokers, and those in homes where smoking was allowed anywhere were much less (OR=0.10; 95% CI=0.06-0.19) likely to have quit. Those with exceptions for special guests did not significantly differ in cessation propensity than those living in smoke-free homes, but those not responding to the home rule questions were only about half as likely to have quit (OR=0.53; 95% CI=0.36-0.78). Besides a smoke-free home, factors related to greater cessation included advanced acculturation, health concerns, a social network discouraging smoking, and a family history of respiratory illness.

The duration of smoking between Hispanic and non-Hispanic whites ever smokers (n=6100) interviewed in the 2001 Colorado Tobacco Attitudes and Behaviours Survey were compared (Burns *et al.*, 2007). Former smokers were defined as being abstinent for at least three months when interviewed. Duration of smoking for continuing smokers was computed as the age when surveyed minus the age of initiation of regular smoking. For former smokers, it was the age when quit minus the age of initiation. Analyses controlled for present age, sex, marital status, language spoken in home, age of smoking initiation, education, poverty status, insurance status, and considered both home (none, partial, complete) and work area smoking restrictions (none or partial versus complete versus not applicable). A partial (hazard ratio: 2.39 (95% CI=1.94-2.94)) or complete (4.59 (95% CI=3.81-5.52)) smoke-free home was associated with shorter smoking durations (cessation). A smoke-free work area (1.48; 95% CI=1.19-1.84) was also important. Results were similar for Latinos and non-Hispanic whites, so the results reported above refer to the combined sample.

Chinese American male smokers (n=600), living in New York City, who took part in a city-wide population survey were the subject of a study conduced in 2002/03 (Shelley *et al.*, 2008). Over one-third (37%) reported living in a smoke-free home, and another third (38%) reported partial restrictions. The authors examined cigarette consumption on weekdays and weekend days, as well as making a recent quit attempt. Those living in smoke-free homes smoked 14.7 CPD on weekdays, with partial restrictions they smoked 17.2 CPD, and with no restrictions they smoked 19.9 CPD. Analogous data for weekend day consumption were: smoke-free 11.8 CPD, partial restrictions 14.7 CPD, and no restrictions 17.3 CPD. Quit attempt rates were 67.0%, 56.7%, and 45.0%, respectively, depending on level of restrictions. Multivariate analyses of cigarettes smoked adjusted for age, education, income, and marital status. Those with a smoke-free home smoked significantly fewer ($p<0.01$) cigarettes both on weekdays and weekend days than those with no restrictions. Partial restrictions were not significantly related to consumption. The odds ratio for making a recent quit attempt was 3.37 (95% CI=1.51-7.05) compared to no restrictions. Again, partial restrictions were not significantly related to quit attempts.

A study of 31 625 recent smokers (in the last year) examined a number of factors related to seriously trying to quit (any length quit attempt in the past year), quitting for one day or longer in the past year, and being quit for at least six months when surveyed (Messer *et al.*, 2008a). Data were from the 2003 Tobacco Use Supplement to the Current Population Survey. Smoke-free homes and workplaces were evaluated along with a number of additional covariates including age, sex, race/ethnicity, education, smoking initiation at <15 years, smoking within 30 minutes of awakening, and use of a pharmaceutical aid. Having a smoke-free home was significantly related to all three outcomes: seriously trying (OR=1.21; 95% CI=1.12-1.30), 1+ day quit (OR=4.03; 95% CI=3.50-4.63),

and 6+ months cessation (OR=4.13; 95% CI=3.25-5.26). A smoke-free workplace was not significantly related to any outcome, and use of a pharmaceutical aid was only significantly related to a 1+ day quit attempt (OR=1.25; 95% CI=1.04-1.49). Older smokers appeared less successful in quitting than younger ones, and further analyses showed that younger smokers smoked fewer CPD and were more likely to have smoke-free homes. The authors concluded that these characteristics might have contributed to their increased success in quitting.

A study from California examined the association between having a smoke-free home and being a former smoker (among ever smokers (n=767) – at least 100 cigarettes in lifetime) and being a light smoker (<10 CPD) among current smokers (n=352) in the Asian Population (Tong *et al.*, 2008). A smoke-free home was categorised as smoking not allowed at all indoors versus all others. The multivariate logistic regression analyses adjusted for age, sex, Asian origin group, marital status, education, income, and years in the USA (<10 vs. all others including those born there), and coded an interaction term for years in the USA and having a smoke-free home. Longer-term residents were more likely (OR=14.19; 95% CI=4.46-45.12) to be former smokers and shorter-term residents were somewhat less but still significantly more likely (OR=2.25; 95% CI=1.79-5.90) to be former smokers if they lived in a smoke-free home compared to those not living in a smoke-free home. Among current smokers, longer-term residents were more likely (OR=5.37; 95% CI=2.79-10.31) to be light smokers if they had a smoke-free home compared to if they did not. There was no significant difference for shorter-term residents (OR=1.19; 95% CI=0.33-4.23).

A recent study is particularly noteworthy in that it analyses cross-sectional Current Population Survey data spanning a full decade (1992/93, 1995/96, 1998/99, 2002/03), and included a total of 542 470 current smokers aged 18 to 64 years (Pierce *et al.*, 2009). The authors examined trends in smoking prevalence, and the proportions of smokers who were moderate to heavy smokers (15+ CPC) and very light smokers (<5 CPD, including occasional smokers) within age groups (18-29, 30-44, and 45-64 years). They also examined trends in the prevalence of report of smoke-free workplaces and homes. The decline in smoking prevalence over the decade appeared to be entirely due to a decline in moderate to heavy smoking in the older age groups, but in the youngest group, the drop in prevalence was modest and there was an increase in the percentage of both very light smokers and in those smoking 5-15 CPD. Because of the increase in very light smoking among the 18-29 year old group, a multivariate analysis was conducted for this age group only, with very light smoking as the dependent variable. Independent variables included survey year, sex, education, income (above versus below two times the poverty level), a smoke-free workplace, and tobacco control policies ranking by tertile for state of residence as an indicator of social norms against smoking. Both a smoke-free home and a smoke-free workplace were significantly related to increased light smoking: ORs were 2.81 (95% CI=2.60-3.04) and 1.28 (95% CI=1.18-1.38), respectively. Also significant was tertile of state tobacco control activity: ORs highest 1.68 (95% CI=1.53-1.85) and middle 1.26 (95% CI=1.15-1.38) versus lowest tertile. Education was directly and poverty status inversely significantly related to being a very light smoker. Of note is that survey year was not significant, but if the variable indicating a smoke-free home was eliminated from the model, year became highly significant; apparently, the increase in light smoking was mediated by the increase in smoke-free homes. There were increases in smoke-free homes documented in all age groups (also in all three tertiles of social norms against smoking), but the level was always higher in the younger age group in each survey year. In 2002/03, the percentages of smokers with a smoke-free home were 36.7%, 28.9%, and 21.7% in the 18-29, 30-44, 45-65 year old age groups, respectively.

Summary

In contrast to mandated smoking restrictions in public or workplaces, those in the home are “voluntary.” There was very consistent evidence that smokers living in smoke-free homes smoke fewer CPD. However, this finding might simply reflect the fact that lighter smokers are more likely to agree to a smoke-free home, as they can more easily adapt to the inconvenience a smoke-free home presents than heavier smokers. Since less addicted smokers are able to quit more readily, it is not surprising that some longitudinal studies that

controlled for smokers' baseline level of addiction failed to find as strong a relationship of home smoking restrictions to subsequent smoking cessation. Some quitters may institute a smoke-free home policy concurrently with a quit attempt or in anticipation of one, and there was generally consistent evidence that quitters living in smoke-free homes stay abstinent longer. Partial home smoking restrictions appeared less associated with smoking behaviour than completely smoke-free policy. In the studies that examined both workplace and home smoking restrictions, home smoking restrictions appeared to have a stronger association with smoking behaviour than did workplace restrictions.

Most of the studies in this section were from the USA. As other countries enact legislation to limit smoking in public and workplaces, restrictions will likely spread voluntarily to homes as well. Further research on the effect of such voluntary restrictions will be warranted.

Effects on youth

Why household smoking restrictions might affect youth smoking behaviour

A smoke-free home should reduce the opportunity for children to observe smoking in their immediate social environment. A behaviour that is frequently observed may come to be considered normal and acceptable, thus increasing the likelihood of adopting the behaviour. Restrictions on smoking in the home at the least express disapproval of exposing children, youth, or other nonsmokers to SHS, and in homes where parents do not smoke it may reinforce the view that smoking is not an acceptable behaviour. Smoking parents who abide by such restrictions are modeling their conviction that their personal behaviour should not affect others deleteriously, and with appropriate framing, a smoke-free home may help convey the message that the parent does not wish the child to initiate smoking.

While it might be thought that smoking parents can do little to prevent their children from smoking, some studies indicate that there are things a parent can do to convey their desire that their child not smoke (Kandel & Wu, 1995; Jackson & Dickinson, 2003). A smoke-free home and other proactive socialisation measures against smoking (e.g. discussion of desire of the parent that the child not smoke, making clear the consequences for the child smoking, etc.) may partially counteract the effect of their own behaviour. In contrast, the absence of such socialisation measures may convey the message that smoking and SHS are not a concern, thus increasing the probability of the child or adolescent initiating smoking, even in homes where parents and other adults do not smoke.

Results for studies examining the effect of home smoking restrictions on youth smoking behaviour

Except for two (den Exter Blokland *et al.*, 2006; Albers *et al.*, 2008), the studies described below are all cross-sectional, with adolescent smoking status ascertained at the same time data on smoking restrictions and other possible determinants of smoking were assessed. As such, they only can determine whether an association exists, and not whether growing up in a home with smoking restrictions lowers the probability of their smoking later (or whether adolescents unlikely to smoke have influenced whether their household restricts smoking). All these studies are summarised in Table 8.8 and described in detail in Appendix 7. All but two of the 19 studies reviewed analysed some measure of youth smoking status. Of these two, one looked at factors related to youth smoking (Conley Thomson *et al.*, 2005), and the other at risk of early smoking initiation (Andreeva *et al.*, 2007).

One of the first studies to examine adolescent smoking in households with and without smoking restrictions, mainly focused on self-reported SHS exposure (Biener *et al.*, 1997). Secondary analyses of these 1606 Massachusetts 12-17 year olds, interviewed in 1993, found that adolescent smoking in the past 30 days was unrelated to the presence of home smoking restrictions.

A survey of central North Carolina 3rd and 5th graders (n=1352) examined early onset of smoking defined as any experimentation and readiness to smoke (intent to smoke when older, thinking cigarettes are easy to get, and whether they had almost smoked), and how these were related to anti-tobacco socialisation measures by their parents (as reported by the children) (Jackson & Henriksen, 1997). Preliminary analyses were stratified according to parental smoking status: 2 never-smokers, 1 or 2 former smokers (but both nonsmokers now), one parent

Table 8.8 Summary of results of studies examining the relationship between home smoking restrictions and *youth* smoking behaviour

		Outcomes			
Reference	**Locality**	**Smoking Status**	**Consumption**	**Cessation**	**Other**
Biener *et al.*, 1997	Massachusetts, USA	NS			
Jackson & Henriksen, 1997	North Carolina, USA	SIG			
Rissel *et al.*, 1997		SIG			
Henrikson & Jackson, 1998	California, USA	SIG			SIG-less intent to smoke
Wakefield *et al.*, 2000a	USA	SIG			
Farkas *et al.*, 2000	USA	SIG		SIG	
Proescholdbell *et al.*, 2000	Arizona, USA	SIG		NS	
Komro *et al.*, 2003	Minnesota, USA	NS			
Kodl & Mermelstein, 2004	USA	SIG			
Andersen *et al.*, 2004	Washington, USA	SIG			
Thomson *et al.*, 2005	Massachusetts, USA				SIG-lower perceived prevalence of adult smoking; SIG-greater perceived adult negative attitudes regarding smoking
den Exter Blokland *et al.*, 2006	Utrecht, Netherlands	NS			
Clark *et al.*, 2006	USA	SIG	SIG	SIG	
Szabo *et al.*, 2006	Australia	SIG			
Fisher *et al.*, 2007	USA	NS			
Andreeva *et al.*, 2007	Ukraine				SIG-later age of first cigarette SIG- later age of daily smoking
Rodriguez *et al.*, 2007	Pennsylvania, USA	NS			SIG-through peer smoking
Albers *et al.*, 2008	Massachusetts, USA	SIG			
Rainio & Rimpela, 2008	Finland	SIG			

SIG = significant difference in smoking behaviour indicated between youth with and without home smoking restrictions. All significant differences were in the direction of reduced smoking (i.e. lower prevalence or status on the uptake continuum, lower consumption, more quitting) in homes with restrictions.
NS = No significant difference
No entry means that the outcome was not considered

a current smoker, and both parents current smokers. As would be expected, across groups there were differences in experimentation and readiness to smoke, with the children with parents who smoked showing the highest levels. While children with parents who were former smokers showed lower experimentation or readiness levels than with parents who were current smokers, they generally had higher levels than those with parents who had never smoked. The investigators conducted separate multivariate analyses of smoking experimentation in children in families with and without parental smokers that controlled for parental smoking status (never or former, one or two adults smoke). These analyses included variables for anti-smoking socialisation factors: expect parents would know if child smoked, expect negative consequences, parent has talked to them about their preference that they not smoke, and child would disregard anti-smoking message from parent. A lack of a smoke-free home was significantly related to early experimentation in homes without an adult current smoker (OR=1.5; 95% CI=1.2-1.83), and only marginally related in homes with one (OR=1.1; 95% CI=0.99-1.2).

Another survey of 3rd through 8th graders (n=937) was conducted in Northern California by the same authors (Henriksen & Jackson, 1998). Three schools that instructed predominantly in English were selected, yet 30% of the students responding were Hispanic. The study examined three measures of anti-smoking socialisation, including home smoking rules (permitted or not permitted), an index of students' report of their parents warning them against smoking, and an index of students' expected punishment if they smoked. Dependent variables were intent to smoke and any experimentation. The indices were categorised for a multivariate analysis of respondents with complete data (n=870) into low, medium, and high groups. The analyses controlled for parental smoking status, but no interactions of this term and the anti-smoking socialisation variables were included. Children living where there were no restrictions on smoking were 1.77 (95% CI=1.19-2.64) times more likely to intend to smoke and 1.39 (95% CI=1.03-1.88) times more like to have tried smoking than children living in a smoke-free home. However, it is unknown whether these effects are mainly from the nonsmoking parental households (70% of sample).

The presence of home smoking restrictions was investigated, as reported by over 17 000 US high school students interviewed in 1996 (Wakefield *et al.*, 2000a). Public smoking restrictions were determined from external sources, and the presence and degree of enforcement of a smoke-free school policy was garnered from students' report to their smoking status. Status was determined by successive levels on a five point smoking uptake continuum. Any smoking in the last 30 days was also analysed. Having home smoking restrictions, particularly a smoke-free home, was associated with a lower level on the smoking uptake continuum at every transition point: non-susceptible to susceptible (OR=0.64; 95% CI=0.52-0.76), susceptible to early experimenter (OR=0.69; 95% CI=0.59-0.79), early experimenter to advanced experimenter (OR=0.71; 95% CI=0.60-0.82), and advanced experimenter to established smoker (OR=0.78; 95% CI=0.67-0.90), as well as reduced 30-day smoking prevalence (OR=0.79; 95% CI=0.67-0.91). A smoke-free home policy and partial home restrictions appeared to be associated with less smoking regardless of the presence of other smokers in the household, but no interaction between these variables was included in the models. Smoke-free policies were more strongly related than partial restrictions.

A non-random sample of 2573 10th and 11th grade students attending high schools with high Arabic and Vietnamese enrollment, examined various factors related to participants' self-reported smoking status (current vs. not current) (Rissel *et al.*, 2000). Included in the logistic analyses, along with year in school, parental smoking, family closeness, sex, ethnic background, parental behaviours (strict vs. not strict, clear vs. not clear consequences), pocket money (<$20/week vs. more), out 0-2 evenings vs. 3+ per week with friends, positive school perceptions, positive teacher perceptions, positive peer perceptions, was students' report of whether or not their family had clear rules about smoking indoors. A 'yes' response was inversely related to current smoking (RR=0.67; 95% CI=0.49-0.90).

Data from the 1992-93 and 1995-96 US Current Population Surveys (n=17 185) allowed examination of the association between workplace and home smoking restrictions (partial or complete versus none) on the self-reported smoking status of over 17 000 15-17 year olds (Farkas *et al.*,

2000). Logistic regression analyses found that adolescents with smoke-free homes were only 0.74 (95% CI=0.62-0.88) times as likely to have ever smoked (at least 100 cigarettes in lifetime) compared to those living with no smoking restrictions. Having partial home smoking restrictions was unrelated to smoking experience. Those working in a completely smoke-free indoor environment were 0.68 (95% CI=0.51-0.90) times as likely to be ever smokers compared to those working where smoking was allowed. An analysis of ever smokers showed that having a smoke-free home was positively associated with being a former smoker (OR=1.80; 95% CI=1.23-2.65). This relationship was not significant for indoor workers in a smoke-free workplace. A further analysis suggested that the rate of adolescent current smoking in households with never smokers only, but with no smoking restrictions, approached that in households with at least one current smoker and partial restrictions or a completely smoke-free home. Perhaps in these settings the lack of a smoke-free home policy communicates implicitly the message that smoking is acceptable.

Tucson, Arizona middle and high school students (n=6686) surveyed in school answered questions about their smoking behaviour, that of their parents, their family structure, the students' perceptions of their parents' attitudes against smoking, and the home smoking policy for family members and for visitors (Proescholdbell *et al.*, 2000). The investigators created a scale for the home policy that considered policies for smokers in the household and for visitors, if no adult household members were smokers. In separate multivariate logistic regression analyses of middle and high school students, those who had never tried smoking were contrasted with those who smoked just one cigarette as the dependent variable. The main effect for the home smoking policy scale indicated that the more restrictive the policy, the less likely the adolescent was to have tried smoking ($p<0.001$). There was a significant interaction for the parent being a current or former smoker with the smoking policy variable only for the high school students ($p<0.01$). Smoking policies in homes with parental smoking appeared less associated with older adolescent smoking experimentation. When current regular smokers (smoked at least one cigarette per month) were contrasted to those who had only tried one cigarette, the home policy scale was not significant. The authors concluded that home smoking policies may be more effective in preventing experimentation than regular smoking.

In 1998, investigators surveyed 1343 Minnesota children (8th, 9th, and 10th graders) and their parents to better understand the relationship between adolescent smoking (any in the last month) and home smoking restrictions (Komro *et al.*, 2003). In the logistic regression, in addition to demographics, a number of potential parental influences that might directly impact adolescent smoking, besides home smoking restrictions, were considered. These included: scales of parental permissiveness of adult smoking, support for smoking regulations (bans and fines), estimates of smoking prevalence among adults and youth, variables assessing parent-child communication about rules and consequences of the child smoking, parental attitude towards punishment for child smoking, adult and other child smoking status in the home as reported by the parent and the child, as well as the extent to which cigarettes were present in the home. A bivariate relationship existed for less smoking with a smoke-free home, but was not evident in the multivariate analysis. The strongest association was for smoking by another child in the home, but most of the other covariates were also significant.

The longitudinal 'Growing up Today' study examined the relation between established (at least 100 cigarettes in lifetime) adolescent smoking and home smoking restrictions (Fisher *et al.,* 2007). Participants (aged 12-18 years) chose one of the following three options as their home smoking rule: 1) People are allowed to smoke inside the house, 2) people are not allowed to smoke inside the house, and 3) there is no rule.

A smoke-free home (option 1) was contrasted to the others. The logistic regression adjusted for age, gender, peer smoking, possession of tobacco promotional items, and having at least one parent who smokes cigarettes. In a model without the variable for parental smoking, adolescent established smoking was inversely associated with a smoke-free home (OR=0.67; 95% CI=0.48-0.93), but the association was not significant when parental smoking was included (OR=0.94; 95% CI=0.65-1.35).

A longitudinal study of 600 families in Utrecht, Netherlands, with at least one child in the 7th grade, examined

the effects of eight indicators of antismoking socialisation, including a scale score computed from six questions on smoking restrictions for adolescents and adults within the home (den Exter Blokland *et al.*, 2006). Students responded to a questionnaire twice within the 2000-2001 school year. Adolescent smoking outcomes were: initiators (those who started smoking by the second wave of the study) and maintainers (those who reported smoking in both waves). Logistic analysis of each outcome variable adjusted for baseline communication, warnings, parental knowledge of child and child's friends smoking, parental psychological control, parental confidence in effecting child's smoking behaviour, availability of cigarettes in the home, parental norms about adolescent smoking, parental reaction to child's smoking, and parental smoking status. There was no significant effect for home rules for either the initiators or maintainers. In families with nonsmoking parents, there were significantly more rules about smoking than in homes where parents smoked.

The relationship was assessed between smoke-free home policies and youth perceptions about smoking: prevalence among youth, prevalence among adults, adult disapproval of adult smoking, and adult disapproval of youth smoking (Conley Thomson *et al.*, 2005). It was noted that each of these perceptions has been associated with youth smoking; the first two directly and the second two inversely. Random telephone survey data from 3831 adolescents 12-17 years of age from Massachusetts were used. In bivariate analyses, no smoking inside the home was significantly associated with each of these perceptions. In multivariate logistic regression analyses, no smoking in the home was significantly associated with lower perceived adult smoking prevalence (OR=2.1; 95% CI=1.7-2.5), but not to perceived adolescent smoking prevalence (OR=1.2; 0.94-1.5). This factor was also significantly associated with high perceived adult disapproval of adult (OR=2.0; 95% CI=1.6-2.5) and of youth smoking (OR=1.5; 95% CI=1.2-1.9). Additional analyses examining interaction effects, found that parental smoking modified the effect of no smoking in the home on perceived adult disapproval of teen smoking, strengthening the odds ratio for the home smoking term (OR=1.9; 95% CI=1.4-2.5). It was concluded that no smoking in the home may provide additional benefits regarding teens' perceptions protective of future smoking above their perceptions of disapproval of teen smoking by their parents.

Adolescent smoking status was assessed in pairs (n=345) of students (grades 6, 8, and 10) and parents as: 1) never users, not susceptible to smoking in the future; 2) never users, susceptible to smoking in the future; 3) former triers; 4) current experimenters; and 5) regular users (Kodl & Mermelstein, 2004). Parents' report of household smoking restrictions were dichotomised as: 1= no one may smoke in the home vs. 0=all others. The adjusted (grade, parental education, and parental smoking) mean percentage of smoke-free homes differed in some contrasts analysed; regular adolescent smokers vs. all others ($p<0.05$), and never smokers nonsusceptible to smoking vs. those susceptible to smoking ($p<0.05$). Contrasts for current experimenters vs. never smokers susceptible to smoking, and for never smokers (susceptible and nonsusceptible) vs. all others were not statistically significant.

In a population-based cohort of 3555 adolescents and their parents, home smoking restrictions were assessed by parental response to whether or not they allow smoking within their home (Andersen *et al.*, 2004). Response categories included: "No," "Rarely," "Sometimes," and "Usually," with the last three categories contrasted with the first one. Self-reported adolescent smoking was categorised as daily or monthly. Families with and without parental report of adult smokers were analysed separately, with the relative risk regression models adjusted for parents asking to sit in nonsmoking parts of restaurants and asking smokers not to smoke around them. In families with parental smokers, a smoke-free home tended to show reduced rates of adolescent daily, but not monthly, smoking (daily: RR=0.74; 95% CI=0.62-0.88, monthly: RR=1.02; 95% CI=0.89-1.17). For nonsmoking families, a smoke-free home was not statistically significant for either daily or monthly smoking.

An analysis similar to that of Farkas *et al.* (2000) was performed using data from the 1998-99 Current Population Survey (n=12 299) (Clark *et al.*, 2006). They only considered home smoking restrictions and analysed persons aged 15-24 years. Consistent with Farkas *et al.* (2000), they found that complete, but not partial home smoking restrictions, were related to

less ever smoking: adolescents (15-18 years) (OR=0.56; 95% CI=0.44-0.71) and young adults (19-24 years) (OR=0.56; 95% CI=0.45-0.70). This was also true for current smoking: adolescents (OR=0.51; 95% CI=0.40-0.67) and young adults (OR=0.45; 95% CI=0.36-0.58). An analysis of current versus former smokers among ever smokers also showed relatively fewer current smokers: adolescents (OR=0.64; 95% CI=0.41-1.00) and young adults (OR=0.33; 95% CI=0.21-0.53). The authors also examined self-reported daily cigarette consumption, contrasting higher levels (6-10 CPD and >10 CPD to 5 or fewer CPD) with polytomous logistic regression. Again, a smoke-free policy was associated with reduced daily cigarette consumption overall (15-24 years): 6-10 CPD (OR=0.40; 95% CI=0.28-0.59) and 10+ CPD (OR=0.51; 95% CI=0.34-0.77).

Another survey of 4125 students 12-17 years conducted in 2002 in Australia (Szabo *et al*., 2006) examined the association of total (inside and outside the house) or partial home smoking restrictions (inside only) with smoking behaviour, considering both smoking in the family and among friends. This study, like the Proescholdbell *et al.* (2000) study, found that the lack of home smoking restrictions compared to total restrictive policy inside and outside, was associated with more smoking in the earlier stages of the smoking uptake continuum: susceptible versus nonsusceptible (OR=1.38; 95% CI=1.06-1.79), experimenter versus non-susceptible (OR=1.92; 95% CI=1.44-2.56), and experimenter versus susceptible (OR=1.39; 95% CI=1.08-1.79). For the analysis of current smokers versus non-susceptible never smokers the odds were 1.30 (95% CI=0.92-1.86) and in the analysis for current versus experimenters they were 0.68 (95% CI=0.48-0.96), indicating paradoxically that current smokers were more likely to reside in smoke-free homes. The authors state that this association was due to inclusion of parental smoking status in the model. When interaction terms with parental smoking were included in the multivariate models, results indicated that smoke-free homes were only associated with being lower on the smoking continuum for households without smokers. As to be expected, smoking by friends was highly associated with smoking behaviour, but there were no significant interactions for this factor with home smoking policy. Likely, peer influences are operative whether or not there is a smoke-free home policy in place.

Data from a 2003 national survey of 6503 12, 14, 16 and 18 year olds in Finland assessed the level of home smoking restrictions (total, partial, none, the respondent could not say), as reported by the respondents with experimental or daily smoking (Rainio & Rimpela, 2008). Multivariate logistic analyses adjusted for the age and sex of the respondent, as well as parental smoking, parental education, urban residence, and parental permissiveness of child smoking. Compared to never smokers, the relationship of a lack of a smoke-free home was stronger for increased daily smoking (OR=14.3; 95% CI=8.6-23.7) than for increased experimental smoking (OR=2.02; 95% CI=1.2-3.4). For increased daily smoking, a smoke-free home appeared to be more strongly related than partial restrictions (OR=2.9; 95% CI=2.3-3.6). For the group that could not say whether there were smoking restrictions in the home, the adjusted odds ratios were somewhat higher than for the partial restrictions, but lower than for a smoke-free policy. A separate analysis of daily smoking in families where both parents smoked produced an adjusted odds ratio of 1.5 (95% CI=0.7-3.0) for partial restrictions, 2.9 (95% CI=1.1-7.8) for no restrictions, and 2.8 (95% CI=1.2-6.5) for 'could not say' compared to a completely smoke-free policy. The authors conclude that a smoke-free home can help prevent smoking even in homes where both parents smoke, and that promoting smoke-free homes within the population is a promising tobacco control tool to prevent smoking among youth.

A Ukrainian study obtained data on 609 young people aged 15-29 years (Andreeva *et al.* 2007). The data included participants' reported age at first cigarette use and age of initiation of daily cigarette smoking. This study compared families with no smokers or with a completely smoke-free home vs. all others. Thus, this categorisation cannot evaluate the potential effect of nonsmoking households prohibiting smoking indoors. Separate survival analyses for males and females adjusted (if significant) for: age, education, town size, living in a city vs. village, number of people in household, income, exposure to tobacco smoke rarely vs. frequently, seeing outdoor tobacco advertising, tobacco-related knowledge low vs. high, receiving information about tobacco from magazines, and receiving tobacco

information from friends. A smoke-free home was associated with reduced risk of earlier first cigarette, both in males (HR=0.78; 95% CI=0.61-0.99) and females (HR=0.39; 95% CI=0.28-0.53). Similarly, a smoke-free home was associated with reduced risk of early initiation of daily smoking (males: HR=0.64; 95% CI=0.49-0.84; females: HR=0.60; 95% CI=0.39-0.93).

A structural equation approach was used to analyse the association of a smoke-free home (household members allowed vs. not allowed to smoke in the home) with adolescent smoking in 163 Pennsylvanian 10th graders with a parental smoker (Rodriguez *et al.*, 2007). This study only assessed the effect of a smoke-free home in families with a parental smoker. Adolescent smoking was determined from a question with a five-level ordered response: 0) did not smoke in the past month; 1) smoked one month ago or less; 2) smoke at least once a week; 3) smoke daily, but no more than 10 cigarettes per day; and 4) smoke 11 or more cigarettes per day. Results indicated that a smoke-free home was associated with having fewer peers who smoked, which in turn was associated with a lower level of smoking. Although the total (indirect plus direct) effect of indoor smoking restrictions was not significant, the indirect effect of adolescent smoking through peer smoking was (ß indirect= -0.569, z=-3.340, p=0.0008).

A longitudinal study (four years: 2001-02 to 2005-06) of 3834 Massachusetts youth (aged 12-17 at baseline), examined the effect of a smoke-free home on transition from never smoking to experimentation, and overall progression to established (at least 100 cigarettes in lifetime) smoking (Albers *et al.*, 2008). A smoke-free home at baseline was defined as visitors not being allowed to smoke inside the home if no adult smoker lived there, and if there was an adult smoker in the household, there was a complete ban on smoking inside. The analysis used a three level hierarchical linear model that analysed individual (two levels) and town level predictors of smoking transitions. Level one individual variables included baseline age and smoking status, presence of a close friend who smokes; level two predictors were gender, race/ethnicity, and household income; town level factors were percentage voting yes on Question 1, percent white, and percent youth. While progression to established smoker was not significantly related to not having a smoke-free home, there was greater significance among adolescents who lived with a smoker (OR=1.38; 95% CI=0.92-2.07) compared to those not living with a smoker (OR=1.08 ; 95% CI=0.61-1.93). The absence of a smoke-free home was associated with the transition from never smoking to early experimentation among youth who lived with nonsmokers (OR=1.89; 95% CI=1.30-2.70), but not for youth living with smokers (OR=0.88; 95% CI=0.73-1.37).

Summary

In 13 of the 19 studies reviewed, at least some evidence for an association between home smoking restrictions and adolescent smoking behaviour was present. One (Albers *et al.*, 2008) of the two longitudinal studies (den Exter Blokland *et al.*, 2006; Albers *et al.*, 2008) showed a significant relationship. The one that did not spanned only a short time interval, less than a full school year, and it is possible that there was not sufficient time for enough transitions to occur.

A single study (Clark *et al.*, 2006) examined cigarette consumption, and found a significant association of a smoke-free home with lower consumption. Three studies examined cessation (Farkas *et al.*, 2000; Clark *et al.*, 2006; Szabo *et al.*, 2006) and two involved older youth from the Current Population Surveys; both showed less current smoking among those who met the adult definition of an ever smoker (at least 100 cigarettes in lifetime). The other study that examined this outcome looked at current smoking among younger youth who had ever experimented and did not find an association (Szabo *et al.*, 2006).

The studies differed in how they accounted for parental smoking. Six studies either included an interaction term for parental smoking and a smoke-free home, or analysed subjects in smoking and nonsmoking homes separately (Biener *et al.*, 1997; Jackson & Henriksen, 1997; Farkas *et al.*, 2000; Proescholdbell *et al.*, 2000; Andersen *et al.*, 2004; Albers *et al.*, 2008). One study found no association in either type of home (Biener *et al.*, 1997), four found a stronger association or an association only in families without adult smokers (Jackson & Henriksen 1997; Farkas *et al.*, 2000; Albers *et al.*, 2008; Proescholdbell *et al.*, 2008), and one study showed an association only in families with adult smokers (Andersen *et al.*, 2004). Nine studies included parental or

adult smoking as a covariate in the multivariate analyses (Henriksen & Jackson, 1998; Rissel *et al.*, 2000; Wakefield *et al.*, 2000a; Komro *et al.*, 2003; Kodl & Mermelstein, 2004; Clark *et al.*, 2006; den Exter Blokland *et al.*, 2006; Fisher *et al.*, 2007; Raino & Rimpela, 2008), and in three of these this variable rendered home smoking rules nonsignificant (Komro *et al.*, 2003; den Exter Blokland *et al.*, 2006; Fisher *et al.*, 2007). Clearly these two factors are highly related and their relative prevalence in the sample might influence the results.

Four studies treated home smoking rules specifically as just one strategy parents could use, among others, to provide anti-smoking socialisation for their children (Jackson & Henriksen, 1997; Henriksen & Jackson, 1998, Kodl & Mermelstein, 2004; den Exter Blokland *et al.*, 2006), and only one (den Exter Blokland *et al.*, 2006) failed to find evidence that this might be a useful anti-tobacco socialisation strategy after accounting for others.

Some studies focused on the earlier stages of the smoking uptake process (Jackson & Henriksen, 1997; Henriksen & Jackson, 1998), some only on the later stages (Farkas *et al.*, 2000; Proescholdbell *et al.*, 2000; Clark *et al.*, 2006; Fisher *et al.*, 2007), and some included analyses for both (Wakefield *et al.,* 2000a; Kodl & Mermelstein, 2004; Andersen *et al.*, 2004; den Exter Blokland *et al.*, 2006; Szabo *et al.*, 2006; Andreeva *et al.*, 2007; Albers *et al.*, 2008; Raino & Rimpela, 2008). Of the 10 studies considering earlier stages, eight found an association, and seven of 12 of those considering the later stages did. The above summary does not include those that focused on last 30-day smoking prevalence, since this measure includes both experimenters and regular smokers.

Taken together these results suggest that while a smoke-free home might be more effective in keeping adolescents from smoking if they live in homes without adult smokers, it is possible that this strategy might also apply to homes with adult smokers. A clear policy about no one smoking in the home ever by anyone might reinforce nonsmoking family norms against smoking, and be a strategy smoking parents can employ to convey to their child their desire that the child not smoke. A smoke-free home might be more likely to prevent experimentation than to prevent progression to established or regular smoking once an adolescent has experimented. There is a need for additional, larger longitudinal population studies of adolescents at each stage of the smoking uptake process to further explore whether the association between smoke-free homes and reduced adolescent smoking is in fact causal.

Chapter Summary

Where data are available, the prevalence of smokers with smoke-free home policies has shown a clear increase over time. Also, there is a shift from report of having partial restrictions to report of completely smoke-free homes. Smokers' reports of smoke-free homes may be a good indicator of population acceptance of the harmfulness of SHS in particular and tobacco control success in general.

Demographic characteristics consistently associated with smokers' reports of smoke-free homes include younger age, male sex, and higher education level. Also related to reports of smoke-free homes are the presence of nonsmokers, particularly children in the home, lower cigarette consumption (or addiction) level, and interest in quitting.

The proportion of children protected from SHS varies greatly by locality and is closely linked to parental smoking prevalence. Where data are available, generally in localities with tobacco control programs that include smoke-free policies, downward trends in children's SHS exposure rates in the home are apparent.

In families with smokers, the presence of smoke-free policies reduces children's exposure to SHS. Less extensive restrictions were not as effective, and in some cases were ineffective. Previous interventions with smokers to decrease SHS exposure in children have generally concentrated on getting parents to quit, and have produced disappointing results. Tobacco control efforts focused on the entire population may do more to reduce SHS exposure than efforts aimed directly at individual parents.

The studies of the effects of home smoking restrictions on smoking behaviour were consistently stronger than those for workplace policies (see Chapter 7). The longitudinal studies show reduced consumption and a more consistent effect on quitting. If a smoke-free home helps quitters remain abstinent longer – and several studies presented evidence that they do – such policies will have a positive impact on eventual increased successful cessation.

The preponderance of evidence to date suggests that fewer adolescent children of nonsmoking parents living in smoke-free homes initiate smoking compared to if the home is not smoke-free. A smoke-free home policy is a clear message from nonsmoking parents to their children that smoking is unacceptable. Whether such a message from a parent who smokes can influence their children not to smoke requires further research.

Conclusions

1. The level of exposure to SHS among children is related to parental smoking, but can be diminished by adoption of a smoke-free home policy.
2. In some localities, population-based strategies, such as public education campaigns on SHS in homes and laws prohibiting smoking in public and workplaces, appear to be more effective in ultimately reducing SHS exposure among children than individual-based programs targeted to parents.
3. When smoke-free public and workplace policies become more common, smokers appear increasingly willing to agree to a smoke-free home policy.
4. Home smoking restrictions lead to reduced consumption and greater quitting among adult smokers.
5. Insufficient evidence exists regarding the effect of smoke-free homes on youth smoking initiation.
6. A smoke-free policy, in which no one is allowed to smoke inside the house at any time under any circumstances, is more effective in reducing smoking than partial restrictions.
7. Home smoking restrictions appear to have a greater effect on smoking behaviour than restrictions on smoking in the workplace.

Recommendations

1. Monitor the prevalence of smoke-free homes among smokers in countries worldwide as a measure of changing population anti-tobacco norms and progress in tobacco control.
2. Conduct public education campaigns to encourage smokers to adopt smoke-free homes.
3. Recommendations to smokers to adopt a smoke-free home should be included in all efforts promoting cessation.
4. Further studies regarding the effect of smoke-free homes on youth initiation are required.
5. Further evidence of the effect of smoke-free homes on smoking behaviour in countries at different stages of the tobacco epidemic is needed.