RESEARCH PAPER

Mortality attributable to passive smoking in Spain, 2002

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Objective: Exposure to environmental tobacco smoke (ETS) is associated with a variety of health effects, including lung cancer and ischaemic heart disease. The objective of this study was to estimate the number of deaths caused by exposure to ETS among non-smokers in Spain during the year 2002

Methods: Prevalence of ETS exposure among never smokers was gathered from three region based health interview surveys. The relative risks of lung cancer and ichaemic heart diseases were selected from three meta-analyses. Population attributable risk (PAR) was computed using a range of prevalences (minimum-maximum). The number of deaths attributable to ETS was calculated by applying PARs to mortality not attributable to active smoking in 2002. The analyses were stratified by sex, age and source of exposure (home, workplace and both combined). In addition, a sensitivity analysis was performed for different scenarios.

Results: Among men, deaths attributable to ETS ranged from 408 to 1703. From 247 to 1434 of these deaths would be caused by the exposure only at home, 136–196 by exposure only in the workplace and 25–73 by exposure at both home and the workplace. Among women, the number of attributable deaths ranged from 820 to 1534. Between 807 and 1477 of these deaths would be caused by exposure only at home, 9–32 by exposure only in the workplace and 4–25 by exposure both at home and in the workplace.

Conclusion: Exposure to ETS at home and at work in Spain could be responsible for 1228–3237 of deaths from lung cancer and ischaemic heart disease. These data confirm that passive smoking is an important public health problem in Spain that needs urgent attention.

Environmental tobacco smoke (ETS) exposure is causally associated with a variety of health effects such as lung cancer, ischaemic heart diseases, respiratory effects and other diseases in adults.[1] Several studies have shown that relative risks (RR) associated with the exposure to ETS are lower than those associated with active smoking.[2–4] However, in most European countries the prevalence of ETS exposure is very high.[5] The large percentage of the population exposed to ETS makes this an important public health issue. For this reason, is important to assess the burden of illness and mortality as a result of exposure to ETS. During recent years, estimates of the mortality attributable to passive smoking in selected populations have been published. Two of the most relevant include those by Woodward[6] in New Zealand and by Jamrozik in the United Kingdom,[7] Anglo-Saxon populations at an advanced stage of the tobacco epidemic.[8]

In Spain, different studies using questionnaires and airborne markers showed that exposure to ETS is an important public health problem, with a very high prevalence of people exposed and levels of ETS usually higher than in most European countries.[9–12] Some authors argued that it could be because of the high prevalence of active smoking and the lack of a restrictive smoking regulation.[11 13] Furthermore, different studies[14 15] have reported incomplete compliance regarding smoking regulations, although this situation may have changed after the new antismoking law implemented on 1 January 2006. Data from surveys carried out in Europe in 1995[5] showed that large proportions of the general population in Spain reported exposure to ETS at home (54%) and at work (60%). Also, the European Community Respiratory Health Survey carried out between 1990 and 1994, in samples of people aged 20–44 from 17 different countries, showed that the highest percentages of people exposed were found in Spain, where five cities were studied, with figures ranging from 55.0% to 75.9%.[16] In the absence of national estimates, region based health interview surveys have reported high levels of exposure to ETS among the general population.[9 12]

While mortality attributable to active smoking has been widely studied and monitored,[17–19] mortality attributable to passive smoking has never been assessed in Spain, to the best of our knowledge. Some approaches have been estimated,[20 21] but no formal studies have been conducted to assess mortality attributable to passive smoking in Spain using data on prevalence of exposure to ETS in our country. The aim of this study was to assess the number of deaths attributable to exposure to environmental tobacco smoke among never smokers in Spain during 2002.

METHODS

Source of data

There are no data on exposure to ETS at the national level in Spain. For this reason, we gathered the data from three region based health interview surveys carried out in 2000, 2002 and 2004: The Barcelona Health Interview Survey 2000 (ESB 2000), The Cornellà Health Interview Survey Follow-up (2002) and Tobacco Galicia Interview Survey (2004)[19 22 23] (table 1). For the Barcelona Health Interview Survey, the population frame was the non-institutionalised population of Barcelona city in the year 2000 (1 600 000 inhabitants) and the sample size was of 10 000 people. For the Cornellà Health Interview Survey Follow-up Study, the population frame was the non-institutionalised population of Cornellà de Llobregat (a town in the metropolitan area of Barcelona of 85 061 inhabitants) and the sample size was the 1608 people (followed from 1994 until 2002). For the survey carried out in Galicia, the population frame was the non-institutionalised population of Galicia

Abbreviations: AM, attributable mortality; ETS, environmental tobacco smoke; OM, observed mortality; PAF, population attributable fraction; PAR, population attributable risk; RR, relative risks

Table 1 Proportion of the never smoking population exposed to ETS in Spain (2000–2004) and relative risks of ETS exposure

	Range of proportion of never smokers exposed to ETS	Relative risk	
		Lung cancer	Ischaemic heart disease
At home only		1.34 (0.97–1.84)[2]	
Men			
35–64 years	0.074/0.226		1.30 (1.22–1.38)[3]
⩾65 years	0.040/0.286		
Women			
35–64 years	0.219/0.330	1.24 (1.13–1.36)[2]	
⩾65 years	0.160/0.308		
At work only			
Men		1.39 (1.15–1.68)[4]	1.21 (1.04–1.41)[3]
35–64 years	0.242/0.359		
⩾65 years	–		
Women			
35–64 years	0.054/0.193		
⩾65 years	–		
At home and at work			
Men			
35–64 years	0.032/0.095		
⩾ 65 years	–	1.39 (1.15–1.68)[4]	1.30 (1.22–1.38)[3]
Women			
35–64 years	0.021/0.120		
⩾65 years	–		

region (northwest, Spain), aged 16 to 74, in the year 2004 (2 130 000 inhabitants). The sample size was of 6492 people. The estimates of exposure to ETS derived from these surveys are reliable and representative of the geographical variability within Spain. Detailed characteristics and results for tobacco smoking and other lifestyles of these health interview surveys have been published elsewhere.[9 12 22 23] The ETS exposure was defined in terms of hours of exposure to ETS in all the surveys, except for exposure at home from the Barcelona Health Survey, where the question asked was ''Does some member of your family usually smoke at home?'' In all cases, we created a dichotomic variable, where ''exposed'' was defined as being exposed at least one hour per week, and ''non-exposed'' was defined as being exposed to ETS less than one hour per week.

In this study, we included the two main diseases widely associated with ETS exposure: lung cancer and ischaemic heart disease. The relative risks (RR) for these diseases were selected from three published meta-analyses used in previous studies[2–4] (table 1).

Knowledge of the observed mortality is the first requirement to ascertain the mortality attributable (AM) to a certain cause. In this case observed mortality refers to deaths caused by lung cancer (ICD-10, C33–34) and ischaemic heart diseases (ICD-10, I20–I25) over the age of 35. The observed mortality figures for diseases related to the use of tobacco in the year 2002 were obtained from the Spanish National Institute of Statistics (INE) database.[25] Mortality was stratified by age groups (35–64 and over 64) and sex, and the number of deaths attributable to active smoking for the same year were excluded. The number of deaths not attributable to active smoking was obtained multiplying the total mortality by the complementary fraction of the population attributable fraction of active smoking (including smokers and ex-smokers) calculated by Montes *et al*[17] for each of the selected diseases. This calculation was done stratifying by age and sex group. The result of this multiplication provides us the observed mortality not attributable to active smoking in 2002 (OM).

The mortality attributable (AM) to ETS was calculated applying the population attributable fraction to ETS (PAF) to the mortality not attributable to active smoking in 2002:

$AM = OM \times PAF$

where PAF was obtained after applying the classic formula[24]

$$PAF = \frac{p*(RR-1)}{p*(RR-1)+1}$$

where p represents the prevalence of non-smokers exposed to ETS and RR refers to the excess risk of those exposed versus the reference category of the non-exposed.

We followed conservative criteria in order to avoid over-estimation of the number of deaths attributable to ETS exposure. Therefore, we did not use data about prevalence of exposure to ETS during leisure time, we did not include ex-smokers and we only took into account two diseases: lung cancer and ischaemic heart diseases. Moreover, we considered people exposed in more than one setting as having the same risk as people exposed in the setting with the higher risk, and the additive risk for both exposures was only used in sensitivity analysis.

In addition to sex and age, the analyses were stratified by setting of exposure (home, workplace and both combined). For each stratum a range of prevalence was used (table 1). The range of prevalences comes from choosing the minimum and maximum value from the three surveys stratified by sex, age and setting. Finally, we performed a sensitivity analyses for different scenarios. We assessed the number of attributable deaths: (1) among ex-smokers who quit smoking more than 10 years ago; (2) using additive risks for people exposed at home and at work; (3) using RR estimated with biomarkers[26]; (4) including deaths attributable to stroke; and (5) including deaths attributable to daily exposure during leisure time.

RESULTS

Among women (table 2), the number of attributable deaths ranged from 820 to 1534. Between 807 and 1477 of these deaths would be caused by exposure only at home, 9–32 by exposure only at work and 4 to 25 by exposure at both home and the workplace. As shown in table 3, deaths attributable to ETS ranged from 408 to 1703 among men. From 247 to 1434 of these deaths would be caused by exposure only at home, 136–196 by

Table 2 PAF and number of deaths attributable to passive smoking among never smoking women, Spain 2002

	Lung cancer (min-max)		Ischaemic heart disease (min-max)		Total (min-max)
	PAF	Deaths	PAF	Deaths	Deaths
Overall ETS exposure					
35–64 years	–	12–31	–	41–84	53–115
⩾65 years	–	37–70	–	730–1349	767–1419
Total	–	49–101	–	771–1433	820–1534
ETS exposure only at home					
35–64 years	0.050–0.073	8–12	0.062–0.090	32–46	40–58
⩾65 years	0.160–0.308	37–70	0.046–0.085	730–1349	767–1419
Total	–	45–82	–	762–1395	807–1477
ETS exposure only at work					
35–64 years	0.021–0.070	3–12	0.011–0.039	6–20	9–32
⩾65 years	–	–	–	–	–
Total	–	3–12	–	6–20	9–32
ETS exposure at home and at work					
35–64 years	0.008–0.045	1–7	0.011–0.058	3–18	4–25
⩾65 years	–	–	–	–	–
Total	–	1–7	–	3–18	4–25

PAF, population attributable fraction; ETS, environmental tobacco smoke.

exposure only at the workplace and 25 to 73 by exposure at both home and the workplace. For both sexes combined, exposure to ETS at home and at work in 2002 would be responsible for 1228 to 3237 of deaths from lung cancer (109 to 290) and heart disease (1119 to 2947).

In the sensitivity analyses (table 4), we first considered ex-smokers susceptible to the effects of ETS, and hence the total number of deaths attributable to passive smoking would range from 2140 to 4149. Secondly, when we assumed exposure at home and at work to be additive, the total number of deaths would range from 1250 to 3304. In a third scenario, using the RR for ischaemic heart disease estimated by means of biomarkers, the total number of deaths would range from 3298 to 8008. Fourthly, if we include stroke, the total number of deaths attributable to ETS would range from 3935 to 9990; and finally, if we consider that people exposed during leisure time are susceptible to ETS effects, the total number of deaths would range from 2870 to 5369.

DISCUSSION

Even under the most conservative assumptions, the number of deaths attributable to ETS in Spain (year 2002) would range from 1228 to 3237 (408 to 1703 among men and 820 to 1534 among women). This is the first study that assesses mortality attributable to ETS in Spain using data on prevalence of exposure in non-smokers from different regions of this country. A recent report published in 2006,[27] that did not use data on prevalence of exposure from our country, estimated 840 deaths from lung cancer and ischaemic heart disease attributable to passive smoking among never smokers in Spain. The study of New Zealand published by Woodward *et al*[6] showed similar proportions to those found in our study, the number of deaths attributable to passive smoking among the total population being the same that the maximum found in our study (8 per 10 000).

One of the main limitations of our study is the lack of data of prevalence on exposure to ETS at national level. However, we

Table 3 PAF and number of deaths attributable to passive smoking among never smoking men, Spain 2002

	Lung cancer (min-max)		Ischaemic heart disease (min-max)		Total (min-max)
	PAF	Deaths	PAF	Deaths	Deaths
Overall ETS exposure					
35–64 years	–	44–83	–	173–349	217–432
⩾65 years	–	16–106	–	175–1165	191–1271
Total	–	60–189	–	348–1514	408–1703
ETS exposure only at home					
35–64 years	0.025–0.071	9–26	0.062–0.090	47–137	56–163
⩾65 years	0.013–0.089	16–106	0.046–0.085	175–1165	191–1271
Total		25–132	–	222–1302	247–1434
ETS exposure only at work					
35–64 years	0.086–0.123	31–44	0.011–0.039	105–152	136–196
⩾65 years	–	–	–	–	–
Total		31–44	–	105–152	136–196
ETS exposure at home and at work					
35–64 years	0.023–0.065	4–13	0.011–0.058	21–60	25–73
⩾65 years	–	–	–	–	–
Total	–	4–13	–	21–60	25–73

PAF, population attributable fraction; ETS, environmental tobacco smoke.

Table 4 Sensitivity analyses of mortality attributable to ETS under different assumptions

Study assumptions	Alternative assumptions	Effect on number of deaths (percentage of increase)	
		Minimum	Maximum
Ex-smokers (>10 years former smokers) not susceptible to effects of ETS	Ex-smokers susceptible to effects of ETS	2140 (74.3%)	4149 (28.2%)
When someone is exposed in both settings there is no additive risk	When someone is exposed in both settings the RR is additive	1250 (1.8%)	3304 (2.1%)
RR of ischaemic heart disease is RR = 1.30–1.21 (home/work)	RR of ischaemic heart disease estimated with biomarkers RR = 1.89[26]	3298 (168.6%)	8008 (147.4%)
There is not enough evidence of stroke	RR of stroke = 2.10 for men and 1.66 for women	3935 (220.4%)	9990 (208.6%)
Exposed in leisure time not susceptible to effects of ETS	Daily exposed in leisure time are susceptible to effects of ETS	2870 (133.7%)	5369 (65.9%)

have used data on exposure from three different areas of Spain, which may reflect a wide range of exposure in the whole country. Furthermore, the questions used in the three interviews were very similar. These data are derived from existing health interview surveys that have included, for the first time in Spain, an assessment of exposure to ETS. Another issue to be pointed out is that the computed number of deaths refers to current deaths that are a consequence of past exposure. The number of deaths nowadays would be higher since the prevalence of exposure to ETS in the past was even higher than the current exposure, as can be derived from the very high levels of active smoking that only began to decrease in the late 1980s. Furthermore, the number of deaths attributed would depend on the order in which the rest of causes of different diseases vary. We have assumed that control of ETS is the first intervention in each instance although in practice this may not be the case.

Our estimate of the number of deaths attributable to ETS is derived from a single estimated relative risk. A more accurate estimate would have resulted from the use of age or country specific relative risks. However, no specific relative risks for exposure to ETS among never smokers are available in Spain, and the use of established RR from the international literature may favour comparability with other studies. Furthermore, a number of studies have shown that special populations, such as hospitality workers, are exposed to higher ETS levels than either people living with smokers or office workers in places where smoking is allowed.[7 28] These subgroups should be considered in future studies.

This study is probably underestimating the real number of deaths because of the conservative criteria used. We only included lung cancer and ischaemic heart disease in the main assessment of deaths attributable to ETS because they are the major diseases firmly linked to exposure to ETS. Stroke was not included in the main estimation since the causal relation with ETS has not been clearly established. If we included this disease in the study,[29] the total number of deaths attributable to ETS would be much higher (3935 to 9990 deaths). While asthma is firmly related to ETS, we discarded it because it causes more morbidity than mortality. On the other hand, sudden infant death was discarded since our study was focused on the adult population (⩾15 years old). Ex-smokers have been excluded from the main goal of our study although there are no plausible reasons to think that they are not susceptible to the risk of exposure to ETS. For this reason, we assessed the number of deaths attributable to ETS in ex-smokers that have quit more than 10 years before. The total number of deaths in this case would increase between 74.3% in the minimum and 28.2% in the maximum. Moreover, we considered that people exposed to ETS at home and at work had the same risk as people only exposed at work. If taken into account together in an additive risk scale, the number of deaths attributable to passive smoking would increase by about 2% in the sensitive analysis.

While we used the relative risk from a meta-analysis based on classic epidemiological designs, a recent study assessing exposure through biomarkers showed that the RR for ischaemic heart diseases could be higher than that assessed through questionnaires only[29]; with a 150% increase in the number of deaths. Finally, while most people are exposed to ETS in their leisure time, we did not include them in the main results because no RR assessed for this source of exposure are available. However, assuming that people exposed daily during leisure time could be exposed to a RR similar to people exposed at work, the number of deaths attributable to ETS would increase by between 134% in the minimum and 66% in the maximum.

Overall, exposure to ETS at home and at work in 2002 would be responsible for between 1228 and 3237 deaths from lung cancer and ischaemic heart disease. The number of deaths caused by exposure to ETS among women is higher than the number attributable to either AIDS or traffic injuries.[25] Among men, the minimum number of deaths would be nearly half those attributable to AIDS. These data confirm that exposure to ETS is a public health problem with a great impact in Spain and argues for legislative measures to create and control smoke-free places.

Owing to the decline in smoking rates and the new smoking ban enacted in January 2006, we would expect the number of future ETS attributable deaths to decline.

What this paper adds

- Environmental tobacco smoke (ETS) exposure is causally associated with a variety of health effects.
- In southern European countries like Spain, the prevalence of exposure to ETS is very high. For this reason, it is very important to assess the burden of illness and mortality because of the exposure to ETS.
- This is the first study that estimates mortality attributable to passive smoking in Spain using real data on prevalence of exposure in never smokers. According to our study, if exposure to ETS was eliminated, there would be between 1228 and 3237 fewer deaths per year in Spain in the future.

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ELECTRONIC PAGES

Tobacco Control Online: http://tc.bmj.com

The following electronic only article is published in conjunction with this issue of Tobacco Control.

"I always thought they were all pure tobacco": American smokers' perceptions of "natural" cigarettes and tobacco industry advertising strategies

Patricia A McDaniel, Ruth E Malone

Objective: To examine how the US tobacco industry markets cigarettes as "natural" and American smokers' views of the "naturalness" (or unnaturalness) of cigarettes.
Methods: Internal tobacco industry documents, the Pollay 20th Century Tobacco Ad Collection, and newspaper sources, and categorised themes and strategies were reviewed, and the findings were summarised.
Results: Cigarette advertisements have used the term "natural" since at least 1910, but it was not until the 1950s that "natural" referred to a core element of brand identity, used to describe specific product attributes (filter, menthol, tobacco leaf). The term "additive-free", introduced in the 1980s, is now commonly used to define natural cigarettes. Market research with smokers, available from 1970 to 1998, consistently revealed that within focus group sessions, smokers initially expressed difficulty about interpretation of the term "natural" in relation to cigarettes; however, after discussion of cigarette ingredients, smokers viewed "natural" cigarettes as healthier. Tobacco companies regarded the implied health benefits of natural cigarettes as their key selling point, but hesitated to market them as it might raise doubts about the composition of their highly profitable regular brands.
Conclusion: Although our findings support the idea advanced by some tobacco control advocates that informing smokers of conventional cigarettes' chemical ingredients could promote cessation, they also suggest that such a measure could also increase the ubiquity and popularity of "natural" cigarettes. A more effective approach may be to denaturalise smoking.
(*Tobacco Control* 2007;**16**:e7) http://tc.bmj.com/cgi/reprint/16/6/e7