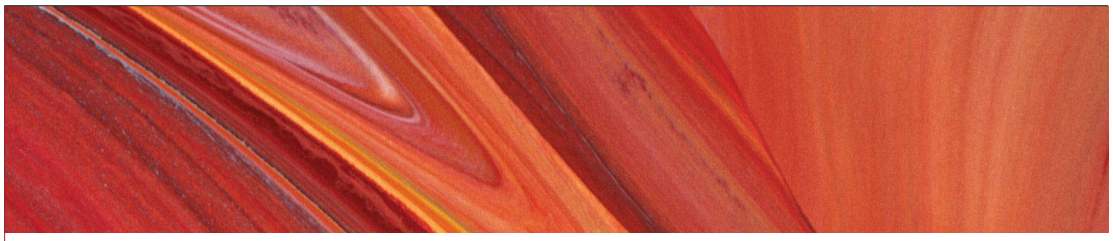

Association between exposure to workplace environmental tobacco smoke and respiratory symptoms

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Abstract

Objective

To assess the relation between exposure to environmental tobacco smoke (ETS) at work and reported respiratory and sensory symptoms.

Design

Cross-sectional telephone survey of members of the Australian Liquor, Hospitality and Miscellaneous Workers Union (Victorian Branch).

Setting

Victoria, September 2001.

Subjects

We studied 382 respondents who worked at least 35 hours per week, worked indoors or in a vehicle, and were never-smokers or former smokers who had quit over one year ago.

Main outcome measures

Reported respiratory and sensory symptoms experienced in the past four weeks.

Results

After controlling for potential confounders, exposure to ETS at work for part of the day was significantly associated with an increased risk of wheeze (OR=4.26), frequent cough (OR=2.26), sore eyes (OR=3.77) and sore throat (OR=2.70). When we stratified the analysis according to whether workers had experienced a cold in the past four weeks, the risk of symptoms disappeared for those who had, and strengthened for those who had not. Among workers who had not experienced a cold, we found strong and dose-response relationships between increasing levels of exposure to ETS at work and morning cough, frequent cough, sore eyes and sore throat, and a positive relationship for wheeze.

Conclusion

These findings provide compelling evidence that indoor workers are adversely affected by exposure to ETS at work and underline the importance of workplace smokefree policies in protecting the health of workers.

Introduction

Environmental tobacco smoke (ETS) refers to the mixture of sidestream smoke (smoke emitted from the glowing end of cigarettes, cigars and pipes) and exhaled smoke that pollutes the air in locations where tobacco is smoked (NHMRC 1997). The link between exposure to ETS and increased risk of respiratory problems and disease has been well established. ETS has been linked to risks of serious disease, such as cancer, heart disease and asthma (NHMRC 1987, 1997; USDHHS 1986; USEPA 1992; NCI 1999) and, more recently, stroke (Bonita et al. 1999). Exposure to ETS irritates the conjunctiva of the eyes (accompanied by reddening, itching and increased watering) and the mucous membranes of the nose, throat and lower respiratory tract (accompanied by itching, coughing and sore throat) (USDHHS 1986).

Since 20.7% of the population in Victoria are regular smokers (Trotter, Mullins & Freeman 2000), there remain many opportunities for non-smoking Victorians to be exposed to ETS in the home and workplace. A recent survey found that 8% of indoor workers aged 18 years and over reported no restrictions on smoking in their workplace, while 21% reported partial smoking restrictions (Letcher & Borland 2000). Exposure to ETS is a particular concern for people employed in the hospitality industry, where exposures are typically highest (Davis 1998). A meta-analysis of studies comparing indoor air quality in bars, offices and homes with at least one smoker concluded that the average level of ETS in bars was 3.9 to 6.1 times higher than in offices, and 4.4 to 4.5 times higher than in smoking homes (Siegel 1993). In 2001, Victoria saw the introduction of smokefree policies in restaurants and shopping centres. While these laws protect the patrons and workers in these establishments, many other workers, including those in bars, clubs and gaming venues, continue to be exposed to ETS on a daily basis. As a result, they remain at an increased risk for developing serious disease and a range of respiratory problems.

All Australian states and territories have Occupational Health and Safety Acts that require employers to provide a safe workplace for their employees and all visitors. The Attorney-General of Australia provided advice which was tabled in the House of Representatives in November 1986. It stated that 'an employer has a common law of duty of care to take all reasonable steps to protect their employees' health and safety, including the provision and maintenance of safe workplaces'. Moreover, 'injury from passive smoking is reasonably foreseeable and … consequently such an injury could give rise to an action for damages at common law' (Winstanley, Woodward & Walker 1995, p. 109). In July 1994, the National Occupational Health and Safety Commission issued a guidance note in regard to passive smoking in

workplaces. It proposed that employers have a legal responsibility to eliminate or control the risk of passive smoking (Winstanley, Woodward & Walker 1995). These arguments provide support for all workplaces to be smokefree under current occupational health and safety legislation.

In summary, research has provided evidence of a relationship between ETS exposure and disease. High levels of ETS in workplaces have been associated with a higher risk of respiratory problems, asthma and lung cancer. This study aims to investigate the relationship between workplace exposure to ETS and self-reported respiratory and sensory irritation symptoms among workers in Victoria.

Method

Procedure

A stratified random sample of members from the Victorian branch of the Australian Liquor, Hospitality and Miscellaneous Workers Union (LHMU) was contacted by telephone in September 2001. This sampling frame included four divisions of workers: hospitality (including bar, hotel and restaurant workers), community services (including child care workers, ambulance paramedics, disability workers and zoo keepers), property services (such as cleaners, car parking attendants and security guards) and manufacturing (such as building products, plastics and laundries). A random selection was made of 1500 members from the hospitality division and 528 members each from community, manufacturing and property divisions. To be eligible for inclusion in the survey, members needed to have worked in the preceding four weeks and be able to speak English.

Trained employees of The Cancer Council Victoria conducted telephone interviews from offices of the LHMU. Interviewers introduced themselves as calling on behalf of the LHMU and The Cancer Council Victoria. Interviewers made up to five attempts to contact LHMU members. The greatest proportion of calls were conducted between 4:00pm and 8:30pm weeknights. A small percentage of calls were made to union members on Saturday afternoons, with the remainder being contacted during business hours.

Questionnaire measures

For this study, we selected participants who reported they worked 35 or more hours per week, the equivalent of full-time work. For these respondents, workplace exposure to ETS was measured by asking them to estimate the

number of hours at work spent per day in the same room as people who were smoking. From these responses, we assigned them to one of three workplace ETS exposure categories: no exposure, greater than 0 to less than or equal to 7.5 hours exposure, or greater than 7.5 hours of exposure per day. Workplace smoking restrictions were recorded by asking questions about the type of smoking restrictions in the respondent's workplace and whether smoking bans applied to their work area. From responses to these questions, we constructed four main categories of smoking restrictions: total ban, ban at usual workstation, no ban at usual workstation and no restrictions.

Home exposure to ETS was determined according to whether the person indicated that they lived with at least one regular smoker. Exposure to ETS outside work and home was measured from questions asking how often the respondent was in the same room as others who were smoking. Responses were coded as often exposed (about half of the time, or most or all of the time) and rarely exposed (rarely or never, or about a quarter of the time).

Questions assessing respiratory and sensory symptoms were adapted from Bates et al. (2001). The respondent was asked if he or she had experienced any of the following in the previous four weeks: wheezing or whistling in chest, shortness of breath, coughed first thing in the morning, coughed frequently, or brought up any phlegm. To assess sensory symptoms, respondents were asked if they had experienced in the last four weeks: red, teary or irritated eyes; runny nose or sneezing; or sore or scratchy throat. To assess the presence of other conditions, including those that could potentially account for these symptoms, respondents were also asked whether they had experienced a cold during the preceding four weeks, whether a doctor had ever told them that they had asthma, and whether they had any health conditions that caused respiratory problems.

Current smokers were defined as people who smoked cigarettes, cigars, pipes or any other tobacco daily, weekly or less than weekly. Recent quitters were designated as having quit smoking less than 12 months ago. Former smokers were defined as having quit smoking for 12 months or more and never-smokers were participants who indicated that they had never smoked. Age, gender, highest level of educational attainment, occupation and postcode were recorded, as well as main occupation and other occupations, hours worked each week, type of workplace and workplace location (indoor/outdoor/in vehicles).

Response rates

Completed interviews were achieved for 1078 LHMU members. Overall, 331 members refused to participate and 263 members had not worked in the preceding four weeks and thus did not qualify for the study. Out of all members contacted and eligible, the response rate was 77%. Table 1 details the percentages of members who were unable to be contacted (due to wrong telephone number or no answer) and those who were not eligible.

Table 1 Survey response rates

Response	Total %
Selected for contacting	**(*n*=3041)**
Incorrect details	19
No answer*	26
Not eligible	9
Contacted & eligible	**46**
	(*n*=1399)
Refused	23
Completed survey	77

**Up to five attempts were made to contact LHMU members.*

In order to assess the relationship between exposure to ETS at work and symptoms, respondents were excluded if they worked less than 35 hours per week, were current smokers, recent quitters (quit within the last 12 months) or worked outdoors. The resulting sample consisted of 382 LHMU members who worked 35 or more hours per week in an indoor environment or in a vehicle and who were never-smokers or former smokers (having quit smoking more than 12 months ago).

Statistical analysis

Statistical analysis was conducted using Stata7 software package. Testing of differences in proportions was conducted at the bivariate level by using chi-square tests, and by analysis of variance for continuous data. Assessment of the relationship between workplace exposure to ETS and respiratory and

sensory symptoms was undertaken using logistic regression analysis, controlling for variables that were potential confounders.

Results

Sample characteristics

Table 2 Sample characteristics

	(*n* =382) %
Gender	
Males	58
Females	42
Age (years)	
Mean (SD)	38.0 (10.8)
Education	
Primary/secondary	58
>Secondary	42
Workplace location	
Indoors	90
Vehicle	10
Workplace restrictions	
Total ban	45
Banned at work area	27
No ban at work area	21
No restrictions	6
ETS exposure	
No exposure	65
>0 to ≤ 7.5 hrs/day	18
>7.5 hrs/day	17
Home ETS exposure	
No home smokers	75
One or more home smokers	25
Other ETS exposure	
Often	16
Rarely	84

As indicated in Table 2, the mean age of the sample was 38 years (SD=10.8), with slightly more males than females. Most respondents indicated they worked indoors, and only 10% worked in a vehicle. Overall, 27% of respondents indicated they either had no smoking ban in their immediate work area or had no smoking restrictions at all in the workplace. Further, 18% reported they were in the same room as someone who smoked for a part of their day and 17% reported exposure to ETS for more than 7.5 hours per day.

Table 3 shows the percentage of respondents who reported respiratory and sensory symptoms in the last four weeks. Overall, 36% of respondents indicated they had experienced a cold in the past four weeks and 18% reported doctor-confirmed asthma. Sensory symptoms were common, with 56% of respondents reporting runny nose in the preceding four weeks, while 41% reported their eyes being red, teary or irritated.

Table 3 Prevalence of respiratory and sensory symptoms during the last four weeks

Symptom*	(*n*=382) %
Wheeze in chest	15
Shortness of breath	12
Cough in morning	14
Frequent cough	17
Phlegm	14
Sore eyes	41
Runny nose	56
Sore throat	34
Cold	36
Asthma	18
Respiratory problem	12
Sick days (≥ 1 day)	30

** No more than three respondents reported unsure to having had a symptom in the previous four weeks.*

Association between work exposure and symptoms

In logistic regression analyses conducted to examine the relationship between work exposure to ETS and symptoms, it was found that workplace smoking restrictions and hours of exposure per day were highly collinear. It was therefore

inappropriate to include both in the analysis and reported hours of ETS exposure was selected as the primary work exposure variable.

Table 4 shows that after adjusting for other sources of ETS exposure and other potential confounders, hours of exposure to ETS at work was significantly associated with an increased likelihood of wheeze, frequent cough, sore eyes and sore throat. There was no relationship between ETS exposure and whether or not a worker had taken sick days.

Table 4 Logistic regression analysis: odds ratios (and 95% confidence intervals) for association of work exposure to ETS and respiratory and sensory symptoms (n=382)

Symptom	Work exposure ≤ 7.5 hours OR (95% CI)	Work exposure >7.5 hours OR (95% CI)
Wheeze in chest	4.26 (1.78–10.21)$^{+}$	2.88 (1.51–7.18)*
Shortness of breath	1.96 (0.79–4.86)	2.06 (0.82–5.17)
Cough in morning	0.88 (0.36–2.15)	2.08 (0.93–4.64)
Frequent cough	2.26 (1.03–4.94)*	2.78 (1.26–6.11)*
Phlegm	2.63 (1.20–5.79)*	1.50 (0.62–3.64)
Sore eyes	3.77 (2.03–7.01)$^{+}$	4.42 (2.33–8.39)$^{+}$
Runny nose	1.13 (0.59–2.19)	1.58 (0.80–3.13)
Sore throat	2.70 (1.40–5.22)$^{+}$	3.05 (1.53–6.09)$^{+}$
Sick days	0.97 (0.51–1.84)	1.14 (0.59–2.24)

Note: adjusted for presence of cold, asthma, respiratory condition, home exposure, other exposure, age, gender and educational attainment.
$P<0.05$, $^{+}P<0.01$.

The logistic regression analyses also showed that, unlike asthma or other respiratory conditions, having a cold in the past four weeks was strongly and significantly related to all symptoms (except sore eyes), with odds ratios significant at the $P<.01$ level for wheeze (OR=3.18), cough (OR=3.87), frequent cough (OR=7.19), phlegm (OR=5.01), runny nose (OR=6.20) and sore throat (OR=4.68) and at the $P<.05$ level for shortness of breath (OR=2.20). Since the strong association found between presence of a cold and symptoms may mask the relationship between other variables and symptoms, we undertook further analyses to look separately at respondents with a cold (n=135) and without a cold (n=244) in the past four weeks.

Table 5 shows that for respondents who had experienced a cold, there was little relationship between work exposure to ETS and symptoms, indicating

that for these respondents, the presence of a cold probably accounted for the experience of symptoms. However, among respondents who had not experienced a cold in the past four weeks, associations between work exposure to ETS and symptoms strengthened. For cough, frequent cough, sore eyes and sore throat, a dose-response relationship existed. In addition, a significant positive relationship was found for wheeze, although this was not dose-response related. Further to the association between respiratory and sensory problems with ETS exposure, we also investigated an association between number of sick days taken in the last month and ETS exposure. The number of sick days taken in the last month was not significantly associated with ETS exposure or respiratory and sensory symptoms.

Table 5 Logistic regression analysis: odds ratios (and 95% confidence intervals) for association of work exposure to ETS and respiratory and sensory symptoms for respondents who did or did not have a cold in the past four weeks

	Cold present (*n*=135)		No cold present (*n*=244)	
Symptom	Work exposure ≤7.5 hours OR (95% CI)	Work exposure >7.5 hours OR (95% CI)	Work exposure ≤7.5 hours OR (95% CI)	Work exposure >7.5 hours OR (95% CI)
Wheeze in chest	3.69 (1.13–12.03)*	2.16 (0.61–7.73)	5.04 (1.30–19.54)*	4.35 (1.10–17.26)*
Shortness of breath	1.08 (0.28–4.12)	1.88 (0.50–7.07)	3.17 (0.83–12.15)	2.41 (0.56–10.31)
Cough in morning	0.36 (0.10–1.30)	1.10 (0.35–3.41)	2.25 (0.55–9.25)	4.93 (1.40–17.34)*
Frequent cough	1.79 (0.67–4.75)	1.27 (0.44–3.70)	4.09 (0.95–17.62)	9.28 (2.64–32.56)+
Phlegm	2.17 (0.75–6.25)	1.26 (0.38–4.11)	3.16 (0.86–11.67)	2.04 (0.47–8.79)
Sore eyes	2.30 (0.87–6.10)	1.97 (0.69–5.65)	5.33 (2.28–12.43)+	7.37 (3.07–17.70)+
Runny nose	0.53 (0.16–1.75)	4.38 (0.51–37.88)	1.56 (0.70–3.44)	1.32 (0.60–2.88)
Sore throat	1.68 (0.64–4.39)	1.02 (0.36–2.85)	4.68 (1.80–12.14)+	7.87 (3.06–20.23)+
Sick days	0.84 (0.33–2.14)	1.57 (0.56–4.39)	0.89 (0.34–2.34)	0.76 (0.31–1.90)

Note: adjusted for presence of asthma, respiratory problem, home exposure, other exposure, age, gender and educational attainment.
** P<0.05, + P<0.01.*

Discussion

This study has found an association between exposure to ETS at work, when measured as hours exposed per work day, and a range of respiratory and sensory symptoms. Workers exposed to ETS at work experienced a significantly increased risk of wheeze, frequent cough, sore eyes and sore

throat – after adjusting for demographic factors, ETS exposure outside work and other conditions that may have accounted for these symptoms. When we stratified the analysis according to whether workers had experienced a cold in the past four weeks, the effect of ETS exposure was weaker among those who had a history of a cold than those who had not. This suggests that a recent history of having a cold masked the relationship between work exposure to ETS and symptoms. Among workers who had not experienced a cold, we found strong dose–response relationships between increasing levels of exposure to ETS at work and morning cough, frequent cough, sore eyes and sore throat. There was also a positive relationship with wheeze.

Some potential limitations of the study deserve mention. First, the study was a cross-sectional survey, which makes it difficult to gain a complete picture of cause and effect. There may be some other factor that accounts for both a higher exposure to ETS at work and respiratory and sensory symptoms that we did not measure. However, we included a wide range of socio-demographic characteristics such as age, gender and highest level of educational attainment in all our models, and we think confounding is an unlikely explanation for these findings.

Second, measures of exposure to ETS and symptoms were self-reported. Questionnaire assessment of exposure to ETS has previously been found to correlate well with biological markers of exposure such as urinary or salivary cotinine (Brownson, Alavanja & Hock 1993; Cummings et al. 1990; Delfino et al. 1993) and personal monitors for ambient nicotine (Eisner et al. 2001). Further, we found a very high concordance between reported hours of exposure to ETS and reported workplace smoking restrictions. In another report, we demonstrated that no workers who reported a total ban at work reported being exposed to ETS at work (Cameron et al. 2002), indicating a very high degree of consistency in measurement of exposure. Questionnaires have been widely used to study the occurrence of acute respiratory illness. The results have been shown to be reliable and to be strongly correlated with doctor visits, lung function tests and other measures of respiratory impairment.

Our findings of an increased risk of respiratory and sensory symptoms associated with exposure to ETS at work are consistent with the findings of previous research (NHMRC 1986, 1997; USDHHS 1986; USEPA 1992; NCI 1999). For example, studies consistently find eye irritation to be the most common response to exposure and document a strong, dose–response relationship between increasing levels of exposure to ETS and greater risk of eye irritation, in terms of reddening, itching, watering and discomfort (for example, Muramatsu et al. 1983; White, Froeb & Kulik 1991). Irritation of the

throat (coughing and soreness) is also found in many other studies. For example, Ng, Hui and Tan (1993) found a significantly higher risk of chronic or usual cough and cough for at least three months of the year for Singaporean women exposed to higher levels of ETS. Janson et al. (2001a) found exposure to ETS to be associated with nocturnal, non-productive and productive cough in a cross-national study in Europe. Leuenberger et al. (1994) found, in a study of 4197 never-smoking adults in Switzerland, that self-reported exposure to ETS was associated with a significantly increased risk of bronchitis symptoms (cough and phlegm) and chronic bronchitis symptoms (cough and phlegm for years). In this study, evidence of a dose-dependent increase in risk was found, demonstrating the cumulative effect of all measures of exposure to ETS, in terms of duration (years exposed) and intensity (hours of exposure per day, whether currently exposed at work, and number of smokers exposed to at work). A study of 5142 never-smoking Hong Kong police officers found the length of time exposed to ETS in the workforce to be positively related to increased doctor consultations for respiratory problems, medication use in the last 14 days and increased time off work for illness (McGhee et al. 2000). These effects were found to be independent of demographic variables, smoking status and exposure to ETS at home.

Our findings pertaining to wheeze deserve comment. Although we found a statistically significant association between exposure to workplace ETS and wheeze, we did not observe a dose–response relationship. Leuenberger et al. (1994) found that exposure to ETS was associated with a significantly increased dose-dependent risk of wheezing, and doctor-diagnosed asthma. Exposure to ETS in the workplace was significantly associated with wheeze and breathlessness and was positively associated with current asthma in a cross-sectional study of 7882 never-smoking adults in Europe (Janson et al. 2001b). Exposure to workplace ETS was also associated with increased bronchial responsiveness. Although dose–response relationships were observed for respiratory symptoms, Janson et al. (2001b) found no relation between dosage of exposure to ETS at work and current asthma.

A limitation of cross-sectional studies is that people with serious respiratory symptoms such as wheezing and asthma may seek to limit their exposure to very high levels of ETS at work because they know that such exposure can exacerbate symptoms. Thus, individuals who are susceptible to the effects of ETS may be less likely to stay in jobs with smoky work environments. As a result, the strength of the association between job conditions and illness is likely to be underestimated.

We conclude that exposure to ETS at work is associated with an increased risk of a range of respiratory and sensory symptoms, including wheeze, frequent cough, sore eyes and sore throat. The study provides compelling local evidence that Victorian workers are adversely affected by exposure to ETS at work, with a higher dose of exposure associated with a worsened respiratory and sensory symptom profile.

This burden of occupational respiratory and sensory symptom distress could be reversed if smoking were to be banned in all workplaces. Evidence demonstrates that only complete bans on smoking can adequately eliminate environmental tobacco smoke from indoor environments such as indoor workplaces (Brauer & Mannetje 1998; Repace 2000). In the US, Eisner, Smith & Blanc (1998) found the introduction of smoking bans in bars in the state of California to reduce the prevalence of respiratory and sensory irritation symptoms and increase pulmonary function among bartenders. At present, the epidemiological evidence indicates that Victorian employers who permit smoking at work are inadequately protecting the health of their employees.

Recently, a non-smoking bar worker in New South Wales (Marlene Sharp) successfully sued her employer for laryngeal cancer attributable to exposure to ETS (Farrant & Connolly 2001; Crawford & Videnieks 2001). Based on sound epidemiological evidence and legal precedent, legislation to mandate smokefree work environments is imperative for the occupational health of all Victorian workers.

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