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Does the workplace-smoking ban eliminate differences in risk for environmental tobacco smoke exposure at work?

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ABSTRACT

Objectives: A workplace-smoking ban in the Netherlands was introduced on January 1, 2004. Before the ban male and low educated employees were at higher risk for exposure to environmental tobacco smoke (ETS). Effective implementation of the ban should result not only in an overall decline of exposure, but also in the disappearance of systematic differences in exposure between subgroups of employees.
Methods: Data from a Dutch continuous Internet survey were used. From July 2003 through June 2005, 200 respondents were randomly selected each week. The sample consisted of 11,291 non-smoking, working respondents, aged 16–65 years.
Results: ETS exposure decreased among all employees and among subgroups at higher risk before the ban. However, also after the ban, males and low educated employees were still most likely to be exposed to ETS.
Conclusions: The workplace-smoking ban was effective in reducing ETS exposure among employees. However, after the ban still 52.2% of non-smoking workers reported to be exposed. We did not find the expected stronger effect among employees who were at higher risk. Both before and after implementation of the ban, males and lower educated employees were about two times more likely to be exposed to ETS.

1. Introduction

There is abundant evidence for the health hazards of exposure to environmental tobacco smoke (ETS), including increased risk for lung cancer, other cancers, coronary heart disease (CHD), respiratory diseases (such as chronic obstructive pulmonary disease (CODP) and asthma), stroke, and complications of pregnancy such as low birth weight and pre-term delivery [1–7]. The main locations for ETS exposure are workplaces and private homes [8–10]. Emmons et al. reported that, in the absence of workplace-smoking bans, approximately 50% of the exposure was at the workplace [11]. Hammond found that 29% of the workers were exposed only at work, while 12% were exposed only at home [12].

One of the most effective public health policies to reduce ETS exposure of non-smokers is the implementation of smoking restrictions or total bans at workplaces and public places [2,3,13–15]. In 2007 approximately 50% of the countries in Europe installed anti-smoking laws for workplaces; other countries have limited or no worksite smoking restrictions [16]. In the Netherlands a full workplace-smoking ban has been in place for all work-

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sites (except in bars, cafes and restaurants) since January 2004. Employers are allowed to provide designated smoking rooms.

An effective implementation of the workplace-smoking ban would imply that after the ban there would be no systematic differences in exposure of non-smokers to ETS at the workplace. This would also mean that the ban would lead to a greater reduction in exposure to ETS among those at higher risk before the ban. Most ETS evaluation studies focused on specific categories of workers like hospitality workers or healthcare staff [10,17–22], or related the level of worksite smoking policy with ETS exposure [23–27]. Studies in the USA [28,29], New Zealand [30], UK/Ireland [31], Scotland [32], Spain [33] and Finland [34], evaluated the impact of a national or state-wide workplace-smoking ban on all types of employees. All seven studies revealed significant reductions of ETS exposure at work after implementation of worksite bans [28–34]. However, only one of these studies examined the effects in risk groups most exposed to ETS before the ban and thus at the highest risk of acquiring ETS-related health problems [30]. In the present study, we analyze whether the workplace-smoking ban reduced exposure to ETS among all non-smoking employees. However, we also focus more specifically on whether some categories of employees are still at elevated risk for exposure to ETS after the ban. Previous studies suggest that high ETS exposure at work is related to younger age, lower education, blue collar workers and being male [23,26,30,35]. Therefore, we expected that the impact of the ban will be stronger in younger employees, employees with lower education, and male employees. Moreover we expected that, among employees who work more hours, the differences before and after the ban would be larger, because they spend more of their time in an environment that was changed by the introduction of the smoking ban. Specific for the Netherlands is that government-related agencies implemented a workplace-smoking ban as early as 1990. Assuming that this ban had an effect, it is likely that the 2004 national workplace-smoking ban has had less effect on employees working at government-related agencies.

2. Materials and methods

2.1. Study design and setting

The Continuous Survey of Smoking Habits (CSSH) monitors smoking prevalence and smoking habits in the Dutch population. Each week 200 respondents are randomly selected from a database of 140,000 respondents representative for the Dutch population aged 15 years and older. To ensure the representativeness, the sample is weighted to region, urbanisation, gender, age, household, education and activity. The subjects were approached by Internet to fill in a questionnaire. For the present study, data collected from July 2003 through June 2005 were used. We selected all 9856 non-smoking, working (≥15 h a week) respondents, aged 16–65 years. We have no information about non-respondents. To check the representativeness of our sample, we compared our sample (smoking and non-smoking) on gender, age and level of education with a sample of the working population from the National Bureau of Statistics. Differences between these two latter samples were small and ranged from 0.5% to 5.0%. Implementation of the workplace-smoking ban was indicated at the time respondents were interviewed: i.e. either just before the ban (the third and fourth quarter of 2003; $n = 2092$), or after the ban (2004 and the first and second quarter of 2005; $n = 7764$).

2.2. Characteristics of the participants

Table 1 presents the characteristics of all respondents in the current study. There were no significant differences in the characteristics of the respondents before (T0) and after (T1) implementation of the ban.

2.3. Questionnaire

Exposure to ETS was measured with the question "How often do colleagues smoke in your presence?" with the answers 'never', 'sometimes', 'regular', 'often' and 'always'. In this article we use mainly a dichotomous variable with the categories 'no exposure' (answer 'never') and 'exposure' (answer 'sometimes', 'regular', 'often' or 'always'). In two analyses we use the ordinal variable (never. . .always). Firstly, to assess whether those reporting to be exposed after the ban reported a lower frequency of being exposed compared with before the ban. Secondly, we used the ordinal variable in a multi-variate analysis to check our outcomes with the dichotomous variable. Furthermore, information on gender (male/female), age (16–29, 30–49, 50–65 years), education level (low/middle/high), type of employer (non-governmental/governmental) and weekly working hours (15–34 h/≥35 h) was acquired using direct questions. The indicator of the implementation of the workplace-smoking ban was before (T0) and after (T1) the ban.

Table 1
Characteristics of the respondents.

	T0 (before the ban) $n = 2092$	T1 (after the ban) $n = 7764$
Gender		
Male	56.7	55.5
Female	43.3	44.5
Age		
16–29 years	17.8	18.6
30–49 years	61.3	60.7
50–65 years	20.9	20.7
Education level		
Low	26.5	27.7
Middle	39.2	39.8
High	34.3	32.5
Type of employer		
Non-governmental	84.2	82.9
Governmental	15.8	17.1
Weekly working hours		
15–34 h	36.1	35.8
35 h or more	63.9	64.2

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2.4. Statistical analysis

Chi-square tests were used to analyze differences in characteristics of the respondents before and after the ban, to assess the proportion that reported being exposed to ETS at work, and to assess differences in exposure in risk groups. Multivariable logistic and linear regression analyses were used to analyze the cumulative contribution of gender, age, level of education, type of employer and weekly working hours to exposure to ETS before and after the ban. Furthermore we tested for interaction effects between the implementation of the ban and the five factors related to exposure to ETS. For all analyses we used a significance level of $p < 0.05$. Data were analyzed using SPSS 15.0 for Windows.

3. Results

3.1. Impact of the ban on the general working population

The first research question addressed the impact of the workplace-smoking ban on self-reported ETS exposure in the general working population. Fig. 1 presents the percentages of employees reporting 'being exposed to ETS at work'. Despite rather large fluctuations per week in the proportion of employees reporting to be exposed, the figure shows that after the ban a smaller proportion of the employees reported to be exposed to ETS. In the weeks before the ban 70.7% of the employees reported being exposed while after the ban this percentage was significantly lower (51.9%; $p < 0.001$).

Among those exposed to ETS, the frequency of exposure decreases significantly ($p < 0.001$). The percentage of employees who reported to be exposed sometimes increased from 51.7% to 58.8%, while reports of being regular, often and always exposed decreased from 31.2% to 27.0% (regular), 10.7% to 8.5% (often) and 6.4% to 5.8% (always), respectively.

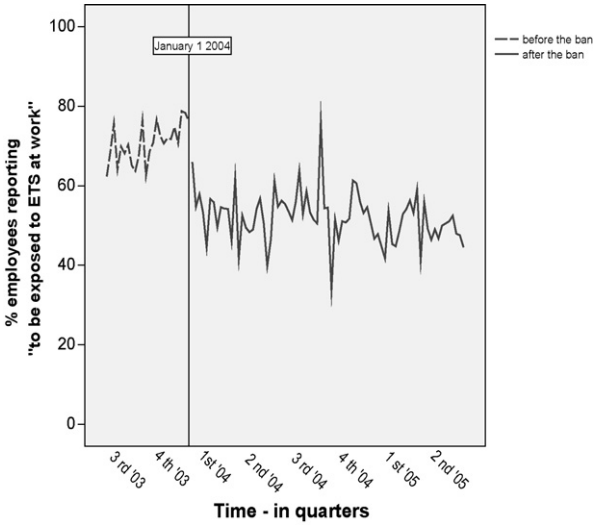

Fig. 1. Percentages of employees reporting "to be exposed to ETS at work" before and after the ban (reported per week).

Table 2
Percentage employees reporting "to be exposed to environmental tobacco smoke at work".

	T0 (before the ban) $n = 2092$	T1 (after the ban) $n = 7764$
General	70.7	51.9[c]
Gender		
Male	76.5[b]	59.8[b,c]
Female	63.2[b]	42.2[b,c]
Age		
16–29 years	68.5	51.4[c]
30–49 years	72.3	51.8[c]
50–65 years	68.0	53.0[c]
Education level		
Low	79.7[b]	61.5[b,c]
Middle	71.0[b]	53.6[b,c]
High	63.5[b]	41.7[b,c]
Type of employer		
Non-governmental	72.0[a]	53.8[b,c]
Governmental	63.9[a]	43.3[b,c]
Weekly working hours		
15–34 h	64.9[b]	44.9[b,c]
35 h or more	74.0[b]	55.8[b,c]

[a] Difference between subgroups ($p < 0.01$).
[b] Difference between subgroups ($p < 0.001$).
[c] Difference between T0 and T1 ($p < 0.001$).

3.2. Impact of the ban on groups at risk for ETS

Secondly, we focused on specific groups at risk for ETS before the workplace-smoking ban. Table 2 shows that before the ban higher levels of ETS were reported for males ($p < 0.001$), lower educated workers ($p < 0.001$), workers with more weekly working hours ($p < 0.001$) and employees of non-governmental agencies ($p < 0.01$). At baseline, males and lower educated workers most often reported ETS exposure at work: 76.5% and 79.7%, respectively.

When we examine the effects for these risk groups, significant improvements were found after the ban for all groups at elevated risk (Table 2).

Nevertheless, also after the ban there were significant systematic differences in risk for ETS by gender, level of education, type of employer and weekly working hours (Table 2). The percentages for ETS exposure after the ban were still the highest for males and lower educated employees: 59.8% and 61.5%, respectively.

3.3. Cumulative contribution to ETS exposure

Two logistic regression analyses were conducted (one before and one after implementation of the workplace-smoking ban) in order to assess the contribution of factors related to exposure to ETS. Self-reported ETS exposure was regressed on gender, age, education level, type of employer and weekly working hours (Table 3).

Before and after the implementation of the workplace-smoking ban gender and education level were most strongly associated with self-reported ETS exposure. Males were nearly twice more likely to be exposed to ETS than females (OR 1.75 and 1.95, respectively), and lower educated employees were even more than two times more likely to be exposed to ETS than higher educated employees (OR 2.29 and 2.17, respectively). We also found that the ORs

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Table 3
Logistic regression for ETS exposure before and after the ban.

Variable	T0 (before the ban)		T1 (after the ban)	
	OR [95% CI]	*p*-Value	OR [95% CI]	*p*-Value
Gender (0 = male/1 = female)	1.75 [1.38–2.21]	0.000***	1.95 [1.74–2.19]	0.000***
Age (0 = 16–29/1 = 30–49 years)	0.9 [.76–1.28]	0.935	1.21 [1.07–1.37]	0.003**
Age (0 = 16–29/2 = 50–65 years)	1.43 [1.04–1.97]	0.030*	1.30 [1.11–1.52]	0.001**
Education level (0 = low/1 = middle)	1.61 [1.23–2.10]	0.000***	1.31 [1.16–1.47]	0.000***
Education level (0 = low/2 = high)	2.29 [1.74–3.01]	0.000***	2.17 [1.91–2.45]	0.000***
Type of employer (0 = other/1 = governmental)	1.24 [.95–1.65]	0.109	1.32 [1.17–1.50]	0.000***
Working hours (0 = 15–34 h/1 = ≥35 h)	.86 [.68–1.09]	0.205	0.93 [.83–1.05]	0.253

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

for the youngest age group (16–29 years) compared with the middle-aged group (30–49 years) and for the type of employer were significantly increased after the ban. Analysis of interactions of the ban with the independent variables did not show any significant interaction, indicating that in the subpopulations of workers the effect of the ban was not stronger than in of the other subpopulations.

Linear regression analyses with exposure as an ordinal (never. . .always) variable yielded similar results. Both gender and education were significant before and after the ban and the change in β for gender ($\beta = 0.22$ and $\beta = 0.26$) and education ($\beta = 0.46$ and $\beta = 0.42$) was very limited.

4. Discussion

The first conclusion of this study is that the workplace-smoking ban in the Netherlands has led to a decrease in the proportion of employees reporting to be exposed to ETS; however, it should be noted that even after the ban the proportion of non-smoking workers reporting to be exposed (51.9%) is still rather high. The decrease also occurred in groups, which before the ban had an elevated risk for exposure to ETS. However, we did not see the expected stronger effect among groups of employees who were at higher risk for ETS before the ban. Therefore, our second conclusion is that both before and after implementation of the workplace-smoking ban, males and lower educated employees are about two times more likely to be exposed to ETS. The significant differences in exposure after the ban according to age and type of employer (see Table 3) are mainly due to the larger number of respondents interviewed after the ban rather than to any substantial change in risk due to the ban.

The decrease in ETS exposure after a workplace-smoking ban found in the present study corresponds with results of earlier review studies on ETS exposure [2,3,14], and with national and state-wide reports [28,30–34]. In our study, the proportion of Dutch non-smoking employees reporting not to be exposed to smoke at work after the ban (48%) is somewhat lower than in Finland (54%) [34] and much lower than in Ireland (86%), Spain (91%) and New Zealand (92%) [30–32]. Apparently there are country differences in how effective a workplace-smoking ban is in protecting non-smoking employees against exposure to ETS. In this case the differences might be partly due to the fact that both the Netherlands and Finland allow designated smoking rooms at the workplace, whereas in Ireland, Spain and New Zealand employers are not allowed to provide such rooms for employees.

We hypothesized that the ban would have the greatest effect on those who were most exposed to ETS before the ban, i.e. males and lower educated employees; this proved not to be the case. The ban did not abolish the systematic differences in exposure to ETS at the workplace. Both before and after the ban male and lower educated employees were at elevated risk for exposure to ETS. Moussa et al. [35] and Edwards et al. [30] also analyzed the influence of sociodemographic factors on ETS after implementation of an anti-smoking ban. Both found the risk for ETS at work to be higher among young adults and among those in lower socioeconomic groups, like workers in blue collar jobs [30,35]. A possible reason for the higher exposure to ETS in males and low educated employees (also after the ban) is that males and lower educated persons are over-represented at worksites known to be least compliant with the smoking ban, e.g. building trade, industry and agriculture [36]. Part of the lower compliance might be due to the fact that in some of these sectors most of the work occurs outdoors.

Possible limitations of this study are that the risk of ETS is not necessarily adequately reflected in 'self-reports' about being exposed to tobacco smoke. However, validation studies comparing environmental or biochemical measures indicating exposure to ETS with self-reports show high correlations between self-reports and environmental measures such as nicotine [37,38] or biochemical measures such as cotinine [8,39,40]. Moreover, reports about exposure might somewhat overestimate the extent to which the workplace-smoking ban is violated. The workplace-smoking ban is principally aimed at securing a smoke-free working place. Because employees might be confronted with smoking colleagues when entering or leaving the building or when passing the designated smoking room inside the building, they may have included these exposures in their report. However, if so, this probably applied to both before and after the implementation of the workplace-smoking ban. Therefore, the change in being exposed is probably a valid indication of the effect of the workplace-smoking ban.

Another possible limitation is the representativeness of the Internet samples used in the present study. In the Netherlands the proportion of people with access to

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Internet (83%) is relatively high [41]. However, a study comparing estimates of substance use based on an Internet sample and on a sample drawn from the general population register (covering >98% of the inhabitants) shows that Internet samples tend to overestimate the prevalence of substance use [42]. Applied to our study this would mean that the proportion of non-smoking workers may have been underestimated. However, when comparing the total sample (smokers and non-smokers) with a sample of the working population from the National Bureau of Statistics we found little indication of selection effects for gender, age or education. Taken together, we think that there is little indication that the main outcomes concerning the effect of the smoking ban, and risk groups for ETS before and after the ban, are not valid for the general non-smoking working population in the Netherlands.

The last limitation of this study is the relatively low numbers of observations before the ban and, associated with this, the limited seasonal variation before the ban. Concerning the number of observations before the ban, Fig. 1 shows enough variation over the period to be confident that the estimates of exposure are rather reliable, also before the ban. Concerning the seasonal variation, both before and after the ban, 50% of the quarters are in the cold season (first and fourth quarter) and 50% in the warmer season (second and third quarter). Therefore we think this has little or no effect on the comparison of exposure before and after the ban.

5. Conclusions

The Dutch workplace-smoking ban led to a decrease in ETS exposure. However, also after the ban still 52% of the employees report to be exposed to ETS during work, although less frequently than before the ban. It would be worthwhile to explore the specific conditions that influence the effectiveness of the ban to protect the non-smoking workers. Furthermore, it is also clear that the groups at elevated risk (male and low-educated employees) are still more often exposed to smoking colleagues after the ban. For these groups more specific, targeted interventions should be developed to protect the non-smokers in these groups from exposure to ETS during work.

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