

The Short-Term Impact of National Smoke-Free Workplace Legislation on Passive Smoking and Tobacco Use

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Since the 1980s, evidence has accumulated on the effects of passive smoking on lung cancer, coronary heart disease, and chronic obstructive pulmonary disease.^{1–7} In March 1995, enforcement of a reformed Tobacco Control Act⁸ expanded the voluntary workplace smoking restrictions that existed in some Finnish firms. The act prohibited smoking on all joint and public premises of workplaces. The employer had 2 options to implement the act: impose a total ban on smoking or allow smoking in designated smoking rooms or areas with separate ventilation systems and lower air pressure than nonsmoking spaces.

To assess the impact of the new legislation, we carried out repeated studies with questionnaires and indoor air nicotine measurements before and after the reformed act came into effect. The main objective was to assess the short-term impact of the law on environmental tobacco smoke (ETS) exposure at work and on smoking habits among employees.

METHODS

We used a repeated cross-sectional design. The first examination took place in winter 1994–1995, when the Tobacco Control Act reform had been passed by the Finnish Parliament but had not yet been implemented; the second round took place during winter 1995–1996, when the act had been in effect for 1 year.

We examined workplaces from the Helsinki metropolitan area, which has a total of 800 000 inhabitants. We selected 12 medium-sized and large workplaces from a registry kept by the Finnish Institute of Occupational Health. These workplaces, both public and privately owned, represented industry, the service sector, and offices. One workplace declined participation because of an ongoing organizational change; another was excluded because of its inability to carry out the ques-

Objectives. This study sought to evaluate the short-term impact of national smoke-free workplace legislation on employee exposure to environmental tobacco smoke at work and on employee smoking habits.

Methods. We performed 2 cross-sectional studies in 9 medium-sized and large Finnish workplaces, before and after implementation of national smoke-free workplace legislation. We assessed tobacco smoke exposure via questionnaire and indoor air nicotine measurements.

Results. Exposure to environmental tobacco smoke declined considerably after the legislation was implemented. Tobacco consumption among smokers diminished. Nicotine concentrations fell significantly.

Conclusions. Legislation was more efficient than voluntary workplace-specific smoking restrictions in reducing passive smoking and cigarette consumption. (*Am J Public Health.* 2001;91:1416–1418)

tionnaire survey in the desired way; and still another was excluded because the company declared bankruptcy between the two surveys. A total of 967 employees (response rate of 69%) participated in the first survey; 1035 employees (response rate 74%) participated in the second survey.

We used sampling pumps to collect vapor-phase nicotine into tubes packed with resin mesh; we then analyzed the samples with a gas chromatograph.⁹ Details on the workplaces, as well as questionnaires, indoor air nicotine measurements, and other aspects of the baseline situation, are described elsewhere.¹⁰

We used a χ^2 test to compare distributions of ETS exposure and smoking prevalences.¹¹ We used the Mann–Whitney test to compare median nicotine concentrations.

RESULTS

The populations in the successive surveys were very similar in terms of the distribution of sex, age, branch of employment, and position at work. The annual change in workforce was 5% to 10%.

Table 1 presents daily ETS exposure of nonsmokers in the workplace before and after implementation of the reform act. In the study population, the distribution of ETS exposure shifted toward less and no exposure after enforcement of the act. For example, the

proportion of employees reporting exposure for 1 to 4 hours daily was halved. The most striking decreases in ETS exposure were in industrial workplaces.

Daily smoking prevalence among employees decreased significantly: from 30% in 1994–1995 to 25% in 1995–1996 (Table 2). Smoking prevalence decreased among men and women. Although the proportion of smokers was inversely associated with level of education in both surveys, the largest decrease was observed among those without a college or university education. The average number of cigarettes consumed daily by current smokers declined significantly: from 19 in 1994–1995 to 16 in 1995–1996. The trend was similar for men and women.

In 1994–1995, the median nicotine concentration was 1.2 $\mu\text{g}/\text{m}^3$ in industrial workplaces, 1.5 $\mu\text{g}/\text{m}^3$ in the service sector, and 0.4 $\mu\text{g}/\text{m}^3$ in offices. A significant decrease was observed in all branches in 1995–1996: The median concentrations were 0.05 $\mu\text{g}/\text{m}^3$, 0.2 $\mu\text{g}/\text{m}^3$, and 0.1 $\mu\text{g}/\text{m}^3$, respectively.

DISCUSSION

Our results showed a remarkably clear decrease in employee exposure to ETS in workplaces 1 year after national legislation on workplace smoking in Finland took effect. The proportional changes were largest in industrial workplaces. Indoor air nicotine con-

TABLE 1—Daily ETS Exposure in the Workplace Among Nonsmokers, by Workplace Category: 1994–1995 and 1995–1996

Daily ETS exposure	Industry			Services			Offices			Total		
	1994–1995 (n = 224), %	1995–1996 (n = 244), %	P ^a	1994–1995 (n = 262), %	1995–1996 (n = 279), %	P ^a	1994–1995 (n = 181), %	1995–1996 (n = 224), %	P ^a	1994–1995 (n = 667), %	1995–1996 (n = 747), %	P ^a
Not at all	8.5	53.7	<.001	27.5	52.0	<.001	20.4	57.6	<.001	19.2	54.2	<.001
<1 hour	20.5	28.3		33.2	32.3		37.6	23.2		30.1	28.3	
1–4 hours	17.4	8.2		21.0	11.4		16.6	7.1		18.6	9.1	
>4 hours	53.6	9.8		18.3	4.3		25.4	12.1		32.1	8.4	

^a χ^2 test for comparison of distribution of ETS exposure in 1994–1995 and 1995–1996.

centrations in the workplaces were consistent with a decreasing trend in ETS exposure; median concentrations showed a significant decline in all workplace branches after the law was enforced.

Daily smoking prevalence among employees decreased considerably. Strikingly, employees with less education showed a proportionally larger decrease in smoking prevalence after implementation of the new legislation. Smoking prevalence and the number of cigarettes consumed daily decreased most among industrial workers.

Questionnaire reports on ETS exposure and personal smoking are vulnerable to misclassification.^{12,13} To support honest and accurate reporting, we designed our questionnaire to be totally anonymous. Consistency between the questionnaire-based results and the indoor nicotine-based assessment of changes in ETS exposure supports the validity of the current study.

We were not able to find any other study in the literature that examined the impact of national smoke-free workplace legislation. Two studies had evaluated the impact of statewide and provincial legislation.^{14,15} In

Finnish national surveys, the prevalence of workplace ETS exposure for at least 1 hour daily decreased from 21% in 1994 to 16% in 1996 among men and from 9% to 6% among women.^{16,17} This trend is consistent with our findings. The national surveys showed lower baseline levels of ETS exposure, probably because they included general population samples, whereas we excluded workplaces with a total ban on smoking to evaluate whether the new legislation was beneficial to employees who were not under adequate protection at baseline. There was no significant decline over time in the general population smoking rates.^{16,17}

Exposure to ETS in the workplace and tobacco use decreased considerably among employees after national smoke-free workplace legislation was implemented. Legislative measures were more effective than voluntary workplace-specific smoking restrictions in diminishing employee exposure to ETS. The clearest decrease in personal smoking prevalence occurred among employees with less than a college education. The present study suggests that legislative measures to restrict smoking at work are more effective than vol-

untary restrictions or health promotion alone in increasing equity in health between education groups. This finding is important because differences in smoking between education levels have widened in Finland during the past 3 decades.¹⁸ ■

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Contributors

A. Heloma designed the study, developed the questionnaire, directed data collection, and wrote the paper. M.S. Jaakkola planned the data analysis, participated in interpreting the results, and contributed to the writing of the paper. E. Kähkönen designed and directed the indoor air nicotine measurements, analyzed the laboratory data, and participated in the writing of the paper. K. Reijula participated in the initiation of the study and the writing of the paper.

TABLE 2—Prevalence of Daily Smoking By Education Level: 1994–1995 and 1995–1996

	Elementary or Comprehensive School			Senior High or Vocational School			College or University			Total		
	1994–1995 (n = 324), %	1995–1996 (n = 333), %	P ^a	1994–1995 (n = 355), %	1995–1996 (n = 361), %	P ^a	1994–1995 (n = 274), %	1995–1996 (n = 312), %	P ^a	1995–1996 (n = 967), %	1994–1995 (n = 1035), %	P ^a
Men	39.7	34.3	.228	33.9	26.9	.068	19.8	19.6	.967	32.3	27.4	.045
Women	32.0	29.5	.723	26.4	19.2	.295	11.8	9.7	.631	22.9	18.6	.220
Total	37.2	33.4	.307	32.9	25.3	.034	16.8	16.0	.790	29.6	25.0	.021

^a χ^2 test for comparison of prevalences in 1994–1995 and 1995–1996.

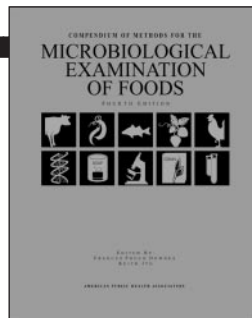
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References

1. *The Health Consequences of Involuntary Smoking. A Report of the Surgeon General.* Washington, DC: US Dept of Health and Human Services; 1986. DHHS publication CDC 87-8398.
2. *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders.* Washington, DC: Office of Health and Environmental Assessment, US Environmental Protection Agency; 1992. Publication EPA/600/6-90/006F.
3. International Agency for Research on Cancer (IARC). *Tobacco Smoking.* Lyon, France: IARC; 1986. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Vol. 38.
4. Committee on Passive Smoking, National Research Council. *Environmental Tobacco Smoke: Measuring Exposures and Assessing Health Effects.* Washington, DC: National Academy Press; 1986.
5. Spitzer WO, Lawrence V, Dales R, et al. Links between passive smoking and disease: a best-evidence synthesis. Report of the Working Group on Passive Smoking. *Clin Invest Med.* 1990;13:17–42.
6. Taylor AE, Johnson DC, Kazemi H. Environmental tobacco smoke and cardiovascular disease: position paper from the Council on Cardiopulmonary and Critical Care, American Heart Association. *Circulation.* 1992;86:699–702.
7. Jaakkola MS. Environmental tobacco smoke and respiratory diseases. *Eur Respir Mon.* 2000;15:322–383.
8. Act amending the Act on Measures to Reduce Smoking (765/1994). Finnish Law. Helsinki, 1994 (in Finnish).
9. Rothberg M, Heloma A, Svinhufvud J, Kähkönen E, Reijula K. Measurement and analysis of nicotine and other VOCs in indoor air as an indicator of passive smoking. *Ann Occup Hyg.* 1998;42:129–134.
10. Heloma A, Kähkönen E, Kaleva S, Reijula K. Smoking and exposure to tobacco smoke at medium-sized and large-scale workplaces. *Am J Ind Med.* 2000;37:214–220.
11. Armitage P. *Statistical Methods in Medical Research.* Oxford, England: Blackwell Scientific Publications; 1985.
12. Willemsen MC, Brug J, Uges DR, Vos de Wael ML. Validity and reliability of self-reported exposure to environmental tobacco smoke in work offices. *J Occup Environ Med.* 1997;39:1111–1114.
13. Jaakkola MS, Jaakkola JJK. Assessment of exposure to environmental tobacco smoke. *Eur Respir J.* 1997;10:2384–2397.
14. Eisner MD, Smith AK, Blanc PD. Bartenders' respiratory health after establishment of smoke-free bars and taverns. *JAMA.* 1998;280:1909–1914.
15. Abernathy T, O'Grady B, Dukeshire S. Changes in ETS following anti-smoking legislation. *Can J Public Health.* 1998;89:33–34.
16. Helakorpi S, Berg M-A, Uutela A, Puska P. *Health Behaviour Among Finnish Adult Population, Spring 1994.* Helsinki, Finland: Publications of the National Public Health Institute; 1994. Publication B 8/1994.
17. Helakorpi S, Uutela A, Prättälä R, Puska P. *Health Behaviour Among Finnish Adult Population, Spring 1996.* Helsinki, Finland: Publications of the National Public Health Institute; 1996. Publication B 12/1996.
18. Laaksonen M, Uutela A, Vartiainen E, Jousilahti P, Helakorpi S, Puska P. Development of smoking by birth cohort in the adult population in eastern Finland 1972–97. *Tob Control.* 1999;8:161–168.



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