Scand J Work Environ Health 2005;31(1):75-81
https://doi.org/10.5271/sjweh.851
Issue date: Feb 2005

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The following article refers to this text: 2008;34(4):267-277

Key terms: beverage server; environmental tobacco smoke; food server; hair nicotine; hospitality industry; lung function; respiratory health; respiratory symptom; smoking; smoking policy

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/15751622

Print ISSN: 0355-3140 Electronic ISSN: 1795-990X

Original article

Scand J Work Environ Health 2005;31(1):75–81

Impact of smoking policy on the respiratory health of food and beverage servers

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Dimich-Ward H, Lawson J, Hingston A, Chan-Yeung M. Impact of smoking policy on the respiratory health of food and beverage servers. *Scand J Work Environ Health* 2005;31(1):75–81.

Objectives The purpose of this study was to determine whether workplace smoking policy was associated with respiratory health effects among food and beverage servers.

Methods Data were obtained from a postal survey of hospitality workers. The participation rate for the questionnaire was 73.9% of those contacted. Current smokers were excluded from the analysis. Adjustment for differences between groups in age, gender, ex-smoker versus never smoker status, home exposure environmental tobacco smoke, childhood asthma, mail versus telephone questionnaire, and hours worked per week was done using logistic regression. A subset of 88 nonsmokers underwent laboratory evaluation, including spirometry and hair nicotine analysis.

Results The prevalence of irritant and respiratory symptoms among 383 nonsmokers was consistently higher among the participants from premises where smoking was permitted without restrictions on the workplace. In comparison with those from facilities where smoking was prohibited, the highest adjusted odds ratios (OR) were for chronic phlegm for those working where smoking was permitted (OR 8.5 95% confidence interval (95% CI) 2.4–30.0] or where there were partial smoking restrictions (OR 5.7 95% CI 1.7–19.4). Lung function was not reduced apart from the ratio between forced expiratory volume in 1 second and forced vital capacity, which was lower for workers from facilities where smoking was permitted. Hair nicotine levels were lowest for workers from facilities where smoking was prohibited.

Conclusions The results suggest that occupational exposure to environmental tobacco smoke, determined through smoking policies, can adversely affect the respiratory health of nonsmokers who work in the food and beverage service industry.

Key terms environmental tobacco smoke; hair nicotine; hospitality industry; lung function; respiratory symptom.

Environmental tobacco smoke, or second hand smoke, is a complex mixture of an aged and diluted mixture of aerosols, vapors, and hundreds of chemical compounds from exhaled mainstream and side-stream smoke, including such respiratory irritants as sulfur dioxide, ammonia, and formaldehyde (1). According to the United States Environmental Protection Agency, environmental tobacco smoke is the most widespread and harmful indoor air contaminant and has been classified as a human (group A) lung carcinogen (2, 3).

The adverse health effects of exposure to environmental tobacco smoke on the health of children are well recognized and include a greater incidence of respiratory symptoms and asthma among schoolchildren whose parents smoke (4). For adults, the effects of exposure to environmental tobacco smoke are less obvious and may be dependent on the source of exposure. Hammond (5) reported typical workplace concentrations of nicotine up to 10 times higher than average home levels, leading her to conclude that a significant number of workers in the United States are exposed to hazardous levels of environmental tobacco smoke. Siegel (6) concluded that environmental tobacco smoke is "a significant occupational hazard for food service workers [p 490]" based on a review of occupational health studies showing increased risks of lung cancer among waiters.

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Hammond et al (7) found worksite smoking policy to have a major effect on nicotine concentrations, which increased from a median of 0.3 μg/m^3 at worksites that banned smoking to 1.3 μg/m^3 at sites that restricted smoking and to 8.6 μg/m^3 at open offices at worksites that allowed smoking. The impetus for adopting increased smoking restrictions has been largely aimed towards the protection of the public, especially children, from health consequences associated with exposure to environmental tobacco smoke (8, 9). Employer liability is also becoming an increasing concern.

The purpose of this study was to determine the relationship between occupational exposure to environmental tobacco smoke as indicated by workplace smoking policy and the prevalence of irritant and respiratory symptoms among nonsmoking food and beverage service workers. An evaluation of the physiological basis for symptoms and exposure to environmental tobacco smoke was conducted using laboratory investigations.

Study population and methods

Postal survey

Ethical approval for the study was obtained by the University Clinical Ethics Review Committee. In the initial postal survey, conducted between February 1997 and February 1999, attempts were made to contact 2184 employees from 17 municipalities in the Vancouver area. Membership lists were obtained from a local union of bar workers, restaurant servers, and hotel workers. Potential participants were sent a letter explaining the purpose and procedures of the study, a self-addressed stamped envelope, and a questionnaire. Repeated attempts were made to contact nonrespondents by telephone and the use of reminder cards, followed by an additional questionnaire. By having the participants complete the questionnaire away from the workplace, we attempted to ensure confidentiality. As shown in table 1, questionnaires were completed by 860 participants. Upon the exclusion of smokers and those who did not work in the food and beverage industry, data from 382 participants were used for the analysis.

Table 1. Participation rate for participants from the hospitality industry.

	Entire sample	
	N	%
Questionnaires sent	2184	·
Unable to contact (invalid phone number, no answer)	568	·
Excluded (not in industry, retired, moved, language barrier)	453	·
Contacted and eligible	1163	100
Refusals	303	26.1
Mail survey participants	860	73.9
Nonsmokers	557	·
Food and beverage servers	383	·
Laboratory study participants	160	55.9
Nonsmoker food and beverage servers	88	·

The postal questionnaire included questions on acute respiratory symptoms based on the questionnaire for asthma-like symptoms of the International Union Against Tuberculosis and Lung Diseases (10), but asked for information over the last 6 months. Questions regarding chronic respiratory symptoms, irritant symptoms, demographic variables, workplace characteristics, and the perception of smokiness were also included.

Laboratory study

A subset of the postal survey participants who resided in or nearby Vancouver were invited to participate in the laboratory portion of the study (participation rate of 55.9%). Out of 160 participants in the laboratory study, data were included from 88 nonsmokers for which information on smoking policy in the food and beverage service industry was available.

Laboratory testing took place in 1998. After informed consent was obtained, a questionnaire-based interview and spirometry were performed. Spirometry was completed using standardized techniques recommended by the American Thoracic Society after the measurement of height and weight. A minimum of three acceptable forced expiratory maneuvers were performed using a computerized 10-liter dry rolling spirometer (S&M instruments, Doylestown, PA, USA) with the participant seated and wearing a nose clip. Forced expiratory volume in the first second (FEV_1), forced vital capacity (FVC), and forced expiratory flow between 25% and 75% of the FVC ($FEF_{25–75}$) were measured and the FEV_1/FVC ratio was computed. Prediction equations were based on data from Crapo et al (11).

A hair sample was obtained for the analysis of nicotine levels based on published protocols (12, 13). About 10 mg of hair was cut close to the scalp at the posterior vertex of the head, to a maximum of 7.8 cm in length (representing approximately 6 months' exposure). The hair was weighed and processed for radioimmunoassay analysis (RIA) by a certified technician who was blinded to the participant's exposure group. The RIA used tritiated nicotine as the tracer, with specific antisera used at a titer of 1:300 and goat anti-rabbit gamma globulin as the precipitating antibody. For quantification, nicotine standards of 0.5 to 50 ng/ml were used. The hair was washed in ultrasonic baths for 30 minutes using dichloromethane, oven dried for several minutes, and then digested by adding 0.46 ml of 1N sodium hydroxide to each sample. Each sample was then capped and

placed in the oven for 20 minutes at 100° Celsius, then neutralized with 41.6 µl of concentrated hydrochloric acid. RIA was performed using a 1:10 dilution. The lower limit of detection was 5 ng/ml, and the upper limit of detection was 500 ng/ml.

Data analysis

The questionnaires and data collection sheets were coded, checked, and keypunched using double-entry techniques. Descriptive data analysis was undertaken using the Statistical Package for the Social Sciences (SPSS Version 10.0, Chicago, IL, USA). Logistic regression was performed using STATA (version 6.0, College Station, TX, USA).

Current smokers, who responded positively to the questions "Have you ever smoked cigarettes regularly (1 or more per day for at least 1 year)?" and "Do you now smoke cigarettes?" were excluded from all the analyses, as were hospitality workers who were employed in hotels. Smoking status was confirmed for the laboratory participants. Workplace smoking policies were classified as "prohibited" (0% of the workplace set aside for smokers), "restricted" (partial smoking restrictions), and "permitted" (smoking permitted in 100% of the workplace). Regulations as to the percentage of smokers allowed in public facilities varied across the municipalities, but greater restrictions were placed on restaurants and other food establishments, in comparison with bars.

The following definitions were used to define the respiratory and irritant symptoms: (i) asthma-like symptoms occurring at any time in the last 6 months [ie, wheeze (had wheezing or whistling in the chest without a cold), awakened by dyspnea (had been awakened by an attack of shortness of breath), awakened by cough (had been awakened by an attack of coughing)], (ii) chronic respiratory symptoms [ie, chronic cough (had a cough on most days of the week for at least 3 months of the year), chronic phlegm (brought up phlegm on most days of the week for at least 3 months of the year)], and (iii) irritant symptoms [ie, burning or itchy eyes (burning or itchy eyes at least once a week while at work), burning or itchy skin (burning or itchy skin at least once a week while at work)].

The differences in the prevalence of symptoms and characteristics between the groups were evaluated using chi-square analysis and an analysis of variance (ANOVA). Multiple logistic regression techniques were used to compute odds ratios (OR) and 95% confidence intervals (95% CI) with symptom as the dependent variable. The analyses by workplace smoking policy group were adjusted for gender, age, childhood asthma, smoking status (ex-smoker for at least 1 year versus never smoker), household smoking, questionnaire type (mail versus telephone) and hours worked per week.

An analysis of the laboratory pulmonary function variables and the hair nicotine levels were undertaken using ANOVA for a comparison of the group means. Hair nicotine levels were log-transformed prior to the data analysis. Multiple regression techniques were applied to adjust the values for between-group differences in the confounders.

Results

Postal study

As seen in table 2, those working in facilities where smoking was permitted had a greater percentage of ex-smokers and tended to work longer in the industry. The shortest workweek was for workers from facilities where smoking was prohibited. With fewer restrictions on smoking, there was an increase in the perception of smokiness and estimates of hours per day of exposure to environmental tobacco smoke. A 100% smoking ban was supported by the majority of respondents (90.5%, 63.3% and 53.7% for the smoking prohibited, restricted, and permitted groups, respectively).

Table 2. Personal and work characteristics for nonsmoking food and beverage servers according to workplace smoking policy.

Workplace smoking policy	Workers' personal characteristics						Workers' work-related characteristics									
	Age (years)		Gender (female) (%)	Childhood asthma (%)	Ex-smoker (%)	Live with a smoker (%)	Smokiness (moderate/heavy) (%)	Bar workers (%)	Years in job		Years in industry		Work-hours/week		Exposure (hours/day)	
	Mean	SD							Mean	SD	Mean	SD	Mean	SD	Mean	SD
Prohibited (N=166)	38.5	12.4	45.2	5.4	26.2	12.9	7.8	10.2	7.0	7.1	13.5	11.3	28.2	12.2	0.6	1.5
Restricted (N=136)	40.0	12.4	48.5	3.8	38.5	20.9	55.1	44.9	7.7	6.9	14.8	9.4	31.0	10.6	5.1	2.9
Permitted (N=81)	40.6	12.3	48.1	8.6	42.3	21.5	77.8	67.9	8.2	7.4	16.6	10.5	31.6	11.2	6.9	2.1
P-value	0.41	·	0.82	0.32	0.02	0.11	0.00	0.00	0.41	·	0.09	·	0.04	·	0.00	·

The prevalence of respiratory and irritant symptoms in each of the groups is shown in figure 1. A higher prevalence of symptoms was consistently observed for those working where smoking was permitted. Reports of adult-onset asthma were found to be significantly higher for those working where smoking was permitted, at 13.6% in comparison with 5.9% and 3.6% for the smoking restricted and prohibited groups, respectively.

Table 3 presents odds ratios for the association between workplace smoking policy and symptoms adjusted for differences in age, gender, childhood asthma, ex-smoking, household smoking, questionnaire type, and hours worked per week. Those working where smoking was restricted or permitted had over five times the risk of chronic phlegm in comparison with those working where smoking was prohibited. In addition, those working where there were no controls on smoking had an increased risk of wheeze and chronic cough. The adjusted odds ratio for adult-onset asthma was elevated but not statistically significant (OR 3.3, 95% CI 0.97–11.4) for the smoking permitted category. The irritant symptom of burning or itchy eyes was significantly higher with work where smoking was either restricted or permitted.

Laboratory study

A comparison of the laboratory study participants with those who completed the postal survey (table 4) showed no differences in characteristics apart from the perception of exposure and the percentage of smoking allowed in the workplace, which were higher on the average for the laboratory participants. No significant differences in respiratory symptoms were found; however, the eye and skin irritant symptoms were higher in prevalence for the laboratory participants (data not shown).

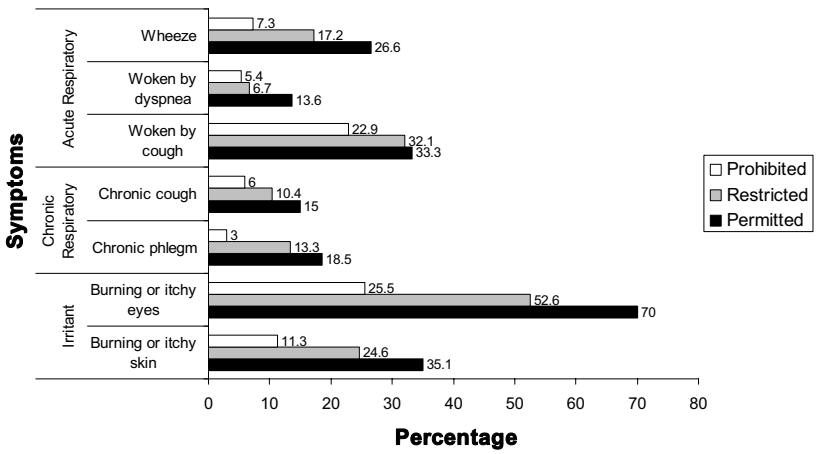

Figure 1. Raw prevalence of respiratory and irritant symptoms for nonsmoker food and beverage servers according to workplace smoking policy.

Table 3. Adjusted odds ratios [a] of symptoms for nonsmoking food and beverage servers according to workplace smoking policy.

Workplace smoking policy	Wheeze		Awakened by dyspnea		Awakened by cough		Chronic cough		Chronic phlegm		Burning or itchy eyes		Burning or itchy skin	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Prohibited	1.0	·	1.0	·	1.0	·	1.0	·	1.0	·	1.0	·	1.0	·
Restricted	2.0	0.8–5.0	0.6	0.2–1.9	1.3	0.7–2.4	2.0	0.7–5.8	5.7	1.7–19.4	2.5	1.4–4.5	1.3	0.6–2.7
Permitted	3.8	1.5–9.4	2.0	0.7–5.7	1.5	0.7–3.0	3.5	1.2–10.4	8.5	2.4–30.0	5.1	2.6–10.2	2.1	0.9–4.9

[a] Adjusted for gender, age, childhood asthma, smoking status (ex-smoker versus never smoker), household smoking, questionnaire type (postal versus telephone) and hours worked per week.

Table 4. Comparison of characteristics of the laboratory participants with the postal survey participants.

Participants	Age (years)		Gender (female) (%)	Childhood asthma (%)	Ex-smoker (%)	Live with a smoker (%)	Work-hours/week		Years in job		Years in industry		Exposure (hours/day)		Smoking allowed	
	Mean	SD					Mean	SD	Mean	SD	Mean	SD	Mean	SD	%	SD
Mail only (N=295)	39.3	12.6	47.8	6.5	33.9	19.0	30.0	11.5	7.3	6.9	14.2	10.5	3.2	3.4	39.3	40.3
Lab (N=88)	40.1	11.8	44.3	2.3	33.7	12.6	30.0	11.6	8.0	7.9	16.0	10.5	4.4	3.4	53.6	43.3
P-value	0.59	·	0.57	0.13	0.97	0.17	0.94	·	0.40		0.17	·	0.01		0.00	·

Table 5. Laboratory results for the nonsmoking food and beverage servers according to workplace smoking policy. (FEV_1 = forced expiratory volume in 1 second, FVC = forced vital capacity, $FEF_{25–75}$ = forced expiratory flow ratio 25–75% of the FVC)

Workplace smoking policy	Predicted FVC (%)		Predicted FEV_1 (%)		Predicted $FEF_{25–75}$ (%)		FEV_1/FVC		Hair nicotine (ng/mg hair)	
	Mean	SD	Mean	SD	Mean	SD	%	SD	Geometric mean	SD
Prohibited (N=22)	104.8	14.3	103.0	14.8	90.8	25.1	81.1	5.4	1.4	2.1
Restricted (N=38)	101.8	13.4	99.2	12.6	95.3	21.3	80.6	5.0	4.6	3.4
Permitted (N=28)	109.1	14.2	104.2	14.6	88.7	24.5	77.8	5.0	5.4	4.7
P-value	0.12	·	0.32	·	0.51	·	0.04	·	0.01	·

The laboratory findings are shown in table 5. There were no significant differences between the smoking policy groups in the percentage of predicted FVC and FEV_1 values, which, on the average, were at least 100% of the predicted. However, the ratio of FVC/FEV_1 was significantly lower among those working in facilities where smoking was permitted. With adjustment for differences in age, gender, race and height, ex-smoker versus never smoker status, number of years in the industry and usual number of hours per week worked, the coefficient of this group failed to reach statistical significance (P=0.07). Significantly lower levels of hair nicotine were found where smoking was prohibited. However, no relationship was found between hair nicotine levels and lung function (data not shown).

Discussion

Food and beverage workers who were nonsmokers employed in establishments that allowed smoking in 100% of the premises had a greater prevalence of acute and chronic respiratory symptoms and of eye and skin irritation. In comparison with workers from facilities where smoking was prohibited, the highest risks (OR >5) were found for phlegm for workers where smoking was either restricted or permitted.

The majority of those working where the policy permitted smoking (68%) was employed in bars. In a 1993 review by Siegel (6), respirable suspended particles measured in bars were three times higher than those taken in restaurants. Restaurant workers in dining restaurants had much lower exposure to environmental tobacco smoke, as measured by breathing-zone nicotine levels and by the quantification of cotinine and 3-hydroxycotinine in urine than workers in pubs and nightclubs (14). Bartenders who worked in single-room facilities have been found to have the highest personal exposures to respirable particulates and nicotine of all the occupations studied (including professional, service industry, clerical and other white-collar workers) (15).

In a recent review of the literature, Jaakkola & Jaakkola (16) concluded that the strongest evidence for a causal relation exists for environmental tobacco smoke and chronic respiratory symptoms (16). The European Respiratory Health Survey of 7882 adults aged 20 to 48 years showed that reporting work exposure to environmental tobacco smoke was related to a higher risk of asthma (OR 1.9, 95% CI 1.25–2.88); there was no significant relationship with the reporting of exposure to home environmental tobacco smoke (17). The relative odds for chronic bronchitis was increased for work exposure to environmental tobacco smoke (OR 1.90, 95% CI 1.16–3.11) in an analysis of data from 1890 German adults within the European Community Respiratory Health Survey (18). Eisner et al (19) found that both lower-level and higher-level environmental tobacco smoke exposures, based on personal nicotine badge measurements, were associated with increased risk of sensory symptoms and of respiratory symptoms (19). According to our study, food and beverage servers who were exposed to high levels of environmental tobacco smoke in their jobs, as determined by workplace smoking policy, had higher risks for symptoms consistent with asthma and chronic bronchitis. They had over five times the risk of chronic phlegm, almost a fourfold risk of wheeze without a cold, and over three times the risk of chronic cough when compared with those working where smoking was prohibited. Chronic phlegm was the only respiratory symptom found to be elevated for subjects from facilities with restricted smoking policies, although there were indications of increased risks for wheeze and chronic cough.

It has been reported that the most common acute effects from exposure to environmental tobacco smoke are sensory irritation of the eyes, nose, throat, and airways that tend to be enhanced with both increasing concentration and increasing duration of exposure (20). Study participants where smoking was permitted were over five times more likely to have itchy eyes and twice as likely to have itchy skin as those with the lowest exposure.

For the small sample of food and beverage workers who underwent spirometry, a slightly lower FEV_1/FVC ratio was noted for the group for which smoking was permitted at work. However, the FVC and FEV_1 values averaged just over 100% of the predicted values,

perhaps indicating a healthy worker selection effect. A California study of 53 bartenders found decreased respiratory and sensory irritation symptoms and an improvement in the mean FEV_1 and FVC a few months after the implementation of a legislative ban on smoking when compared with levels prior to the ban (21). Cross-sectional studies on the effects of workplace exposure to environmental tobacco smoke on lung function have shown contradictory results. There was a significantly lower percentage of predicted FEV_1, FVC, and $FEF_{25–75}$ observed for Iranian men exposed to environmental tobacco smoke, the greatest adverse effect of exposure to environmental tobacco smoke being found for the men who were exposed at various types of workplaces (22). Recently, Chen and his colleagues (23) reported that never smokers highly exposed to environmental tobacco smoke at work had reduced FEV_1 and FVC. An analysis of the ratio of the two lung function parameters was not reported. In contrast, a large cross-sectional study of office workers (24) found very few differences in lung function according to exposure to environmental tobacco smoke.

Hair nicotine levels were lowest for those working where smoking was prohibited; this finding confirmed that occupational exposure to environmental tobacco smoke was related to workplace smoking policy. A recent study of 114 food and beverage servers from bars and restaurants found hair nicotine levels of nonsmokers to be highly related to workplace smoking policy (25). Similarly, a previous study of 26 persons showed a significant exposure gradient of nicotine in hair that was highest for those working in bars where there were no public smoking restrictions (13).

Despite evidence that smoking restrictions do not have a negative impact on restaurant sales (26), there is often resistance within the hospitality industry and within segments of the population to increase the restriction or eliminate smoking in public eating establishments. However, surveys of employee attitudes have generally shown that the majority support smoking restrictions in the workplace (27). Heloma & Jaakkola (28) found that a nationally implemented some-free workplace law was associated with steadily reducing exposure to environmental tobacco smoke at work and found both smokers' and nonsmokers' attitudes shifting towards favoring a total ban on smoking at work. We found that the majority of workers surveyed supported a 100% smoking ban, ranging from almost all of those working in facilities where smoking was prohibited to just over one-half of those working where smoking was allowed throughout the premises.

Our study has several limitations associated with the cross-sectional design, including recall and selection biases. Although statistical adjustment was made to account for differences in distribution for several potential confounders, there remains the possibility of effects due to unmeasured confounders or effect modifiers, such as exposure to alcohol, smoking nontobacco products, and other factors possibly related to the lifestyle of bar workers as opposed to restaurant workers. The outcomes for the postal survey were based on the reporting of symptoms, and such surveys are subject to inaccuracy, particularly when there may be an awareness of negative health effects being associated with exposure to environmental tobacco smoke. The quantitative measures of lung function showed only slight and inconsistent differences between the groups.

Exposure based on current smoking policy is subject to misclassification of the extent of past and present occupational exposure to environmental tobacco smoke. The more objective measure of hair nicotine levels confirmed that increased long-term exposure to environmental tobacco smoke was found for food and beverage service workers where 100% of the workplace was designated for smoking. No exposure-response relationships of hair nicotine and lung function were found, although the analysis was hindered by a small group sample size and a low response rate. Workplace smoking policies have been shown to clearly make a substantial difference in the concentration of environmental tobacco smoke in the workplace (5, 7). An Ontario study of 180 public sites determined that 1 year after the implementation of smoking restrictions, there was an overall decrease in environmental tobacco smoke of about two-thirds across all the sites tested (29).

In conclusion, we found a significantly higher prevalence of respiratory and sensory irritation symptoms among nonsmokers who work in food and beverage service facilities where there were few restrictions on smoking. Objective testing of health outcomes of a larger sample of persons, more refined exposure assessment, and a longitudinal study of changes in the health status of workers with changes in exposure are recommended to investigate further the occupational health risks related to exposure to environmental tobacco smoke at levels typically found in the hospitality industry.

Acknowledgments

We would like to thank Henry Chan for the hair nicotine measurements and Anne DyBuncio for the data programming. This study could not have been undertaken without the co-operation of Local 40 of the Hotel Restaurant Culinary Workers & Bartenders Union.

Financial support for the project was provided by the BC Health Research Foundation, the National Health Research Development Program and the BC Lung Association. Salary support for Dr Dimich-Ward was

provided by a BC Lung Association/CIHR Investigator Award.

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Received for publication 29 December 2003