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Occupational secondhand smoke is the main determinant of hair nicotine concentrations in bar and restaurant workers

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ABSTRACT

Objective: To evaluate the relative contribution of occupational vs. non-occupational secondhand tobacco smoke exposure to overall hair nicotine concentrations in non-smoking bar and restaurant employees.
Method: We recruited 76 non-smoking employees from venues that allowed smoking ($n=9$), had mixed policies (smoking and non-smoking areas, $n=13$) or were smoke-free ($n=2$) between April and August 2008 in Santiago, Chile. Employees used personal air nicotine samplers during working and non-working hours for a 24-h period to assess occupational vs. non-occupational secondhand tobacco smoke exposure and hair nicotine concentrations to assess overall secondhand tobacco smoke exposure.
Results: Median hair nicotine concentrations were 1.5 ng/mg, interquartile range (IQR) 0.7 to 5.2 ng/mg. Time weighted average personal air nicotine concentrations were higher during working hours (median 9.7, IQR 3.3–25.4 μg/m^3) compared to non-working hours (1.7, 1.0–3.1 μg/m^3). Hair nicotine concentration was best predicted by personal air nicotine concentration at working hours. After adjustment, a 2-fold increase in personal air nicotine concentration in working hours was associated with a 42% increase in hair nicotine concentration (95% confidence interval 14–70%). Hair nicotine concentration was not associated with personal air nicotine concentration during non-working hours (non-occupational exposure).
Conclusions: Personal air nicotine concentration at working hours was the major determinant of hair nicotine concentrations in non-smoking employees from Santiago, Chile. Secondhand tobacco smoke exposure during working hours is a health hazard for hospitality employees working in venues where smoking is allowed.

1. Introduction

Exposure to secondhand tobacco smoke (SHS) remains a major public health problem worldwide (Jones et al., 2013; Oberg et al., 2011). In the absence of smoke-free legislations, studies in Europe, United States, Australia and South America have identified bars, pubs, restaurants and discos as the work environments with the highest concentrations of tobacco smoke (Bolte et al., 2008; Gorini et al., 2008; Navas-Acien et al., 2004; Nebot et al., 2005; Rosen et al., 2008; Siegel and Skeer, 2003) resulting in high secondhand tobacco smoke exposure among the employees who work for long hours in these venues (Agbenyikey et al., 2011; Jones et al., 2013).

Chile had implemented a partial smoking ban in public venues at the time of this research (National Congress of Chile, 2006). The legislation required separate areas for smokers and nonsmokers in bars, restaurants and pubs with surface for public use exceeding 100 m^2. In venues with surface less than 100 m^2, the owner could decide the smoking status of the venue (National Congress of Chile, 2006). Workers in venues that allowed smoking were unprotected compared to workers in smoke-free venues. Similar to other research conducting environmental assessment in hospitality

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venues (Apelberg et al., 2013), we found that air nicotine concentration in smoking venues from Santiago, Chile, was 10 times higher than concentrations of smoke-free venues (Erazo et al., 2010).

To assess internal dose, previous studies in hospitality venues have measured and compared secondhand tobacco smoke biomarkers among employees (e.g. urine cotinine or hair nicotine) according to the smoking status of the workplace (Al-Delaimy et al., 2001; Ellingsen et al., 2006; Jensen et al., 2010). Some studies have also evaluated the relationship between environmental measures in the workplace (e.g. air nicotine concentrations or particulate matter $< 2.5\ \mu m^2$) and secondhand tobacco smoke biomarker concentrations (Agbenyikey et al., 2011; Jones et al., 2013; Valente et al., 2007). However, no other study of bar and restaurant employees have assessed both work and non-work environment simultaneously and linked those environmental data with a tobacco-specific biomarker of internal dose. Non-occupational sources of SHS, especially smoking exposure at home, could be particularly important in countries with a relatively high prevalence of smoking, such as Chile (National Health Survey, Chile, 2009–2010).

The main objective of this study was to evaluate the relative contribution of occupational vs. non-occupational secondhand tobacco smoke exposure to overall exposure as measured by hair nicotine concentrations in non-smoking employees in bars and restaurants in Santiago, Chile. To measure occupational vs. non-occupational secondhand tobacco smoke exposure, we used personal air nicotine samplers during working and non-working hours for a 24-h period. To measure overall secondhand tobacco smoke exposure, we used hair nicotine, because it is a reliable and accurate biomarker of past tobacco smoke exposure that integrates multiple sources, including exposure at work, home and transportation.

2. Methods

2.1. Study design and participant recruitment

This cross-sectional study is part of a larger tobacco control project conducted between April and August 2008 in Santiago, Chile, aimed to evaluate a partial smoking ban legislation that had been enacted in Chile in 2006 (National Congress of Chile, 2006). We visited bars and restaurants located in 4 neighborhoods with a high concentration of public places where people, especially young adults, spend time or gather socially. A total of 63 venues were visited using a door-to-door sampling strategy. In each venue we explained the study aims to the manager/owner and evaluated eligibility (be bar, pub or restaurant and have two or more non-smoking employees). A non-smoking employee was defined as a worker who stated that he/she had not smoked in the last year. To be included in the study, owners/managers had to agree to answer a questionnaire, allow install air nicotine samplers in the venues for one week and allow the employees to be interviewed.

Of 63 visited venues, 25 refused to participate and 13 did not meet the inclusion criteria. We also excluded one venue because the air sampler was lost during the fieldwork. For this report we used information from 24 venues (9 allowed smoking, 13 had smoking area and non-smoking area (mixed) and 2 were smoke-free). To be included in the study, employees from the venues had to be non-smoking, be present on the first day of venue air nicotine concentration measurement, answer a questionnaire, wear two personal passive air samplers to measure air nicotine concentrations during 24 h (one sampler for working hours and another sampler for non-working hours), be present the next day at the same hour (to collect the personal samplers), and provide a hair sample. A total of 97 non-smoking workers were invited to participate and 2 refused. All participants provided informed consent and the study protocol was approved by the ethical committee of the Faculty of Medicine, Universidad de Chile, Santiago, Chile. The feasibility of the study procedures were assessed in a pilot study. Data were collected by trained fieldworkers using a standardized protocol.

2.2. Data collection

After scheduling an appointment with the owner/manager, the field team visited the venue during working hours but before the venue was open to public for data collection. Trained interviewers administered two standardized questionnaires (one for the owner/manager and another for the non-smoking employee). The owners/managers were asked data on general characteristics of the bar or restaurant, including smoking policy (allowed, total ban, or mixed), opening hours, legal occupancy, self-reported average occupancy, and ventilation systems. The non-smoking employees were asked to provide information on demographic characteristics (age, gender, education, job title (bartenders/ waiters/ owner/ manager/ cook)), chemical hair treatment, number of work days per week in the venue, work shift, hours of secondhand tobacco smoke exposure per week at work and/or in other environments and number of cigarettes smoked per day by other household members.

2.2.1. Air nicotine

After the interviews with owners and employees, the fieldworkers placed the air nicotine samplers in the venue and provided air nicotine samplers to the employees. The passive samplers were designed and analyzed following the method originally developed by Hammond and Leaderer (1987). The sampler consists of a 37-mm plastic cassette containing a support pad, a filter treated with sodium bisulfate and a polycarbonate diffusion membrane, which were assembled at the Secondhand Smoke Exposure Assessment Laboratory of the Johns Hopkins Institute for Global Tobacco Control.

To measure air nicotine concentrations in each venue, the fieldworker placed two samplers at around two-meter height in a central area in the venues that allowed smoking and in the smoke-free venues. In mixed venues, the fieldworker placed one sampler in the smoking section and another sampler in the non-smoking section making sure that the front side of the sampler faced the room being monitored. After the sampler was placed, the fieldworker filled the sampler sheet information recording the date and time installation. 10% duplicate samplers following the same process were used during the fieldwork. All venue samplers were left for 7 days (sampling for 24 h per day). Fieldworkers visited the venue at an hour of maximum public attendance to verify the correct placement of the sampler and to record information on the estimated number of customers and the number of smokers over a period of 15 min.

The measurement of personal air nicotine concentration started immediately after finishing the employee's questionnaire. To measure personal exposure to secondhand tobacco smoke during working (occupational) and non-working hours (non-occupational), each participant was provided with and instructed to use two samplers, one personal sampler during working hours and another personal sampler to be used out of working hours (since the employee left work until he/she returned the next day) up to a total of 24-h (Aceituno et al., 2010). The fieldworker showed the participant how to clip the personal sampler to his/her clothes, to store them safely at the end of the sampling time (covered with caps and isolated in plastic containers), and to record the amount of sampling time for each sampler. At the end of the 24-h sampling period, the fieldworkers retrieved the personal samplers and stored them in a smoke-free place until shipment to the Exposure Assessment Facility at the Bloomberg School of Public Health.

In the laboratory, air nicotine concentration was analyzed using gas chromatography with nitrogen selective detection. The airborne concentration of nicotine was calculated by dividing the amount of nicotine collected by each filter (μg) by the volume of air sampled (m^3). The volume of air sampled is equal to the minutes of sampling multiplied by the sampler flow rate (25 ml/min) (Hammond and Leaderer, 1987). The limit of detection was $0.014\ \mu g/m^3$. Three personal samplers used during non-working hours had nicotine concentration below this value and were replaced by the limit of detection divided by square root of 2 (Hornung and Reed, 1990).

2.2.2. Hair nicotine

A small hair sample (approximately 30–50 strands) was cut near the hair root from the back of the scalp, where there is most uniform growth pattern among individuals. Hair samples were stored in a smoke-free environment at room temperature and shipped in labeled plastic bags to the Exposure Assessment Facility at the John Hopkins Bloomberg School of Public Health for analysis of nicotine content. After removing the nicotine attached externally to the hair using a 30 min bath in dichloromethane, the hair samples were digested with sodium hydroxide and the nicotine extracted using dichloromethane. The extracts were analyzed by gas chromatography with mass detector (Kim et al., 2009). To calculate the hair nicotine concentration, the amount of nicotine (ng) was divided by the mass of hair analyzed (mg). Seven samples with hair nicotine concentrations below the limit of detection (0.02 ng/mg) were replaced by the limit of detection divided by square root of 2 (Hornung and Reed, 1990).

2.3. Statistical analyses

Descriptive analyses (proportion, median, interquartile range, and range) were conducted to summarize participants and venue characteristics. To determine if hair nicotine concentration, personal air nicotine (at working hours and non-working hours) and venue air nicotine were normally distributed, we applied Shapiro–Wilk test. Since data did not distribute normally, they were transformed to the natural logarithm. The bivariate relationship between hair nicotine concentrations and air nicotine concentration (raw data) was explored using Spearman correlation.

To evaluate the association of personal air nicotine concentration (at working hours and non-working hours) on hair nicotine, separate models were constructed.

Log_2 –transformed nicotine concentration was used as continuous variable to evaluate the association of hair nicotine concentration with doubling in personal air nicotine concentrations (occupational and non-occupational). First, the log_2 hair nicotine was regressed on log_2 personal air nicotine concentration measured during working hours. Then, regression models were adjusted. To select covariates to include in the model, we considered changes (> 10%) in regression coefficients of personal air nicotine concentration when the covariates were added to the crude model. Five covariates met this criterion sex, amount of cigarettes consumed per day by others household members, number of working days per week in the venue, chemical hair treatment and work shift hours. In addition to fitting models using personal air nicotine concentration during working hours, similar models using personal air nicotine concentration during non-working hours were fitted to evaluate the contribution of each exposure variable (personal air nicotine concentration during working hours and personal air nicotine during non-working hours) to the overall hair nicotine concentration.

We also evaluated the potential modifying effects of covariates over the relationship hair nicotine concentration and personal air nicotine concentration during working hours. The criteria used to identify interaction was p-value < 0.05.

3. Results

3.1. Employee characteristics

Of the 95 employees who agreed to participate, the hair was too short in four of them. In eight workers the hair samples were insufficient for analysis and in seven the personal samplers (six work samplers and one out of work sampler) were not recovered, leaving 76 participants for this study. Sociodemographic characteristics were similar for participants included ($n=76$) and not included ($n=19$) (data not shown).

The employees in this study were more likely to be men, to work over 40 h per week, and to be bartenders/waiters (Table 1). Most participants worked in smoking allowed and mixed venues and only four participants worked in smoke-free venues. Among participants who worked in smoking allowed and mixed venues, 85.7% and 63.6% respectively, reported that their clothes and/or hair smelled of tobacco after work. Over 50% of participants from smoking and mixed venues lived with a smoker, while 3 out of 4 participants from smoke-free venues lived with a smoker.

3.2. Air nicotine concentrations

Personal air nicotine concentrations were higher during working hours (median 9.7, interquartile range 3.3–25.4 $\mu g/m^3$) compared to non-working hours (median 1.7, interquartile range 1.0–3.1 $\mu g/m^3$) (Table 1). Median (interquartile range) personal air nicotine concentrations during working hours were 24.7 (9.8–34.8) $\mu g/m^3$ among employees working in venues that allowed smoking, 5.5 (2.6–13.6) $\mu g/m^3$ among employees working in mixed venues and 3.9 (3.1–5.1) $\mu g/m^3$ among employees working in smoke-free venues (Table 1). Workplace indoor air nicotine concentrations measured during a 7-day period were higher in venues that allowed smoking (median 13.5 $\mu g/m^3$) and smoking areas in mixed venues (8.8 $\mu g/m^3$) compared with non-smoking areas in mixed venues (1.1 $\mu g/m^3$) and smoke-free venues 0.1 $\mu g/m^3$).

3.3. Hair nicotine concentrations

The median (interquartile range) hair nicotine concentration was 1.5 (0.7–5.2) ng/mg (Table 2). Hair nicotine concentrations were higher in men, older participants, bartenders or waiters, participants with evening work shifts, participants of smoking allowed venues and participants who lived with a smoker. Hair nicotine concentrations were lower in participants with chemical hair treatment. One employee working in smoke-free venue but highly exposed to secondhand smoke at home (over 60 cigarettes per day) had a hair nicotine concentration of 13.7 ng/mg. Excluding this participant, the median hair nicotine concentrations for participants working in smoke-free venues were 0.6 ng/mg. Hair nicotine concentrations were correlated with personal air nicotine concentrations at working hours (*Spearman* correlation=0.43; *p-value*=0.0001), but not with personal air nicotine concentrations outside working hours (*Spearman* correlation=0.14; *p-value*=0.21) or with time-weighted air nicotine concentrations measured inside the venue for a 7-day period (*Spearman* correlation= −0.06; *p-value*=0.60).

After adjustment for sex, amount of cigarettes consumed per day by others household members, number of work days per week in the venue, chemical hair treatment and work shift hours,

Table 1
Employee and venues characteristics, Santiago, Chile, 2008.

	Bar/restaurant smoking status			
	Smoking allowed	**Mixed**	**Smoke-free**	**Overall**
Number of venues	9	13	2	24
Number of employees	28	44	4	76
Sociodemographic characteristics				
Age (years)[a]	29.0 (22.5–41.5)	30.5 (26.0–41.0)	22.0 (20.0–28.0)	30.0 (23.5–40.5)
Men (%)	67.9	65.9	50.0	65.8
Years of schooling (%)				
< 8	3.6	13.6	0.0	9.2
9–12	35.7	45.5	50.0	42.1
≥ 13	60.7	40.9	50.0	48.7
Bartenders/waiters (%)	67.9	61.4	0.0	
Number of years working in this venue[a]	1.5 (0.5–5.5)	2.0 (0.5–5.0)	1.9 (0.4–4.0)	1.8 (0.5–5.0)
Number of hours worked per week[a]	42.3 (34.5–60.0)	50.5 (46.5–60.0)	51.0 (36.0–59.0)	48.0 (40.0–60.0)
Exposure to secondhand smoke				
Living with a smoker (%)	53.9	53.9	75.0	55.1
Hours/week of SHS exposure[a]	48.0 (23.5–64.5)	46.5 (15.5–58.0)	21.0 (7.0–35.0)	45.0 (18.0–60.0)
Tobacco smell after work (%)	85.7	63.6	25.0	69.7
Chemical hair treatment (%)	32.1	15.9	100.0	21.1
Air nicotine concentrations ($\mu g/m^3$)[a]				
Statique venue sampler				
Smoking area	13.5 (9.5–16.8)	8.8 (3.9–17.9)	–	
Non-smoking area	–	1.1 (0.3– 1.7)	0.1 (0.1–0.5)	
Personal occupational sampler	24.7 (9.8–34.8)	5.5 (2.6–13.6)	3.9 (3.1–5.1)	9.7 (3.3–25.4)
Personal non-occupational sampler	1.7 (0.99–3.6)	1.6 (1.0– 3.2)	2.1 (1.6–2.4)	1.7 (1.0– 3.1)

[a] Median (interquartile range).

Table 2
Hair nicotine concentrations by participant and venue characteristics, Santiago, Chile, 2008.

	No. of Employees	Median	Interquartile range	Range
Overall	76	1.46	0.71–5.15	0.01–82.67
Sex				
Male	50	2.93	1.02–6.31	0.01–82.67
Female	26	0.78	0.38–1.03	0.01–13.52
Age				
≤ 30	41	1.03	0.61–3.86	0.01–25.79
> 30	35	1.83	0.79–6.25	0.01–82.67
Occupation				
Bartender/Waiter	46	2.82	0.86–6.18	0.01–82.67
Others	30	0.81	0.51–1.90	0.01–25.79
Work shift				
7:00–17:00	14	0.44	0.01–2.69	0.01– 7.92
17:00–7:00	62	1.73	0.81–5.50	0.01–82.67
Chemical hair treatment				
Yes	16	0.78	0.30–0.96	0.01– 2.93
No	60	2.43	0.79–6.22	0.01–82.67
Cigarettes consumed per day by others household members				
None	42	1.05	0.46–5.22	0.01–82.67
≥ 1	34	2.62	0.79–5.09	0.21–36.63
Venue smoking status				
Smoking allowed	28	1.81	0.77–5.85	0.01–82.67
Mixed	44	1.27	0.71–4.48	0.01–36.63
Smoke-free	4	1.18	0.31–7.63	0.01–13.52
Type of venue				
Bar/pub	49	1.89	0.51–6.18	0.01–82.67
Restaurant	27	1.09	0.79–3.86	0.01–13.52
Ventilation system				
Yes	72	1.46	0.74–5.15	0.01–82.67
No	4	1.48	0.33–5.03	0.01–7.75

Table 3
Geometric mean ratio (95% confidence interval) of hair nicotine concentrations (ng/mg) by a doubling of personal air nicotine concentrations ($\mu g/m^3$) at working and non-working hours, Santiago, Chile, 2008.

Hair nicotine concentration	Crude	Adjusted[b]
Personal air nicotine concentration during working hours ($\mu g/m^3$)[a]	1.51 (1.21–1.81)	1.42 (1.14–1.70)
p-value for trend	0.001	0.001
Personal air nicotine concentration out of working hours ($\mu g/m^3$)[a]	1.04 (0.72–1.35)	0.93 (0.67–1.20)
p-value for trend	0.724	0.476

[a] Log_2 transformation.
[b] Adjusted by sex, amount of cigarettes consumed per day by others household members, number of working days per week in the venue, chemical hair treatment and work shift hours.

a 2-fold increase in personal air nicotine concentration in working hours (occupational exposure) was associated with a 42% increase in hair nicotine concentration in non-smoking employees (95% confidence interval 14%–70%) (Table 3). Personal air nicotine concentrations measured out of working hours (non-occupational exposure) was not associated with hair nicotine concentration. The corresponding determination coefficient (R^2) for the crude and adjusted models were 0.16 and 0.43 for personal air nicotine during working hours and 0.0007 and 0.33 for personal air nicotine out of working hours respectively.

We found no evidence of potential effect modification of the association between secondhand tobacco smoke exposure during working hours with hair nicotine concentrations by participant characteristics.

4. Discussion

This exposure assessment study among non-smoking employees in bars and restaurants in Santiago, Chile, found that occupational exposure to secondhand tobacco smoke, measured with personal air nicotine samplers, showed the strongest association and was a better predictor of hair nicotine concentration compared to non-occupational exposure, confirming that occupational exposure is the major source of secondhand tobacco smoke in non-smoking hospitality employees working in venues that allow smoking.

This is the first study comparing secondhand tobacco smoke exposure during working and non-working hours using two personal samplers of air nicotine and its relation with a biomarker of overall secondhand tobacco smoke exposure such as hair nicotine. This methodology allowed us to evaluate the relative magnitude of occupational exposure to secondhand tobacco smoke compared to other sources of exposure during the day. Moreover, the use of personal monitors provided a better estimation of individual occupational exposure compared to static workplace monitors. Personal monitors integrate secondhand tobacco smoke exposure from different spaces where the employee spends time, including bathrooms, kitchen areas, offices and outdoor areas. Personal monitors are especially important in mixed venues because employees need to move between smoking and non-smoking areas. They can also be useful in smoke-free venues, as most of these venues still allow smoking in outdoor areas that the workers need to attend. In our study personal air nicotine concentrations during working hours for workers in smoke-free venue were higher than expected (median 3.9 $\mu g/m^3$) given the very low air nicotine concentrations measured during a 7-day period inside the venue (median 0.1 $\mu g/m^3$). It is possible that the exposure levels reflected by the personal monitors are related to outdoor exposure. Additional studies are needed to evaluate secondhand tobacco smoke from outdoor areas among hospitality workers. Studies in occupational settings have shown that exposure to secondhand tobacco smoke is related to acute (Pilkington et al., 2007; Wakefield et al., 2005) and chronic health effects (Menzies et al., 2006; Stayner et al., 2007). Future studies accessing health effects of occupational exposure to secondhand tobacco smoke should consider the use of personal air nicotine monitoring.

Hair nicotine is a biomarker of chronic exposure to secondhand tobacco smoke, because each centimeter of hair represents approximately one month of exposure (Al-Delaimy, 2002). It is a non-invasive biomarker, easy to transport and store, and highly sensitive, detecting trace quantities. As any other biomarker, however, it is not useful to identify the source of exposure to secondhand tobacco smoke. Recently, a large study conducted in cities from different regions of the world showed a clear association between hair nicotine concentrations and venue indoor air nicotine concentrations in both smoking and non-smoking employees (Jones et al., 2013). Similar to our study, they found higher hair nicotine concentrations for employees working in venues where smoking was allowed compared to non-smoking venues. In this study, the association with 1-day occupational exposure using personal air nicotine monitors was clear, however we did not find association between venue air nicotine concentrations measured during 7 days and hair nicotine concentrations as described in previous studies (Agbenyikey et al., 2011; Jones et al., 2013). The reasons for the lack of association are unclear. Maybe it is due to the relatively small number of venues evaluated. It could also be affected by the employees in mixed venues, for whom the daily exposure pattern to secondhand tobacco smoke can vary markedly depending where they make the work-shift. In our study it was not possible to determine if workers were allocated to the smoker or non-smoker area during the measurement period.

Study limitations include: a) The small number of smoke-free venues, reflecting that this type of venues is very rare in Chile and consistent with the lack of success to support voluntarily the smoking-free legislations (Erazo et al., 2010; Fernandez et al., 2009). b) Personal air monitors were worn only during 24-h, a short period compared to the 7-day monitoring for air nicotine and the longer half-life of hair nicotine concentrations. Despite this short duration, we found a clear association between air nicotine concentrations measured during work time and hair nicotine concentrations. c) The venues were recruited using a convenience sampling approach. However, the venues and the employees, were recruited from popular neighborhoods in Santiago and were comparable to many other venues and workers around the city.

Strengths of this study include the comprehensive assessment of secondhand tobacco smoke exposure using well-established and highly specific methods to measure secondhand tobacco smoke (hair nicotine concentration, personal air nicotine concentration and venue air nicotine concentration). We also evaluated the number of self-reported hours exposed to secondhand tobacco smoke which showed to be a predictor of hair nicotine concentration (R^2=0.06; data not shown). Another strength of this study is that variables included in the model explain a 43% of the variance in hair nicotine concentration among non-smoking workers, higher than that reported by others studies where age, gender, educational status, type of venue, and number of sources of secondhand tobacco smoke, only account of 12% of the variance in hair nicotine (Okoly et al., 2007). Finally, the most important strength is the fact that this is the first study conducted in bar and restaurant employees that assess exposure to SHS both work and non-work environment and linking it with a biomarker of internal dose in the same study.

5. Conclusion

This exposure assessment study confirmed, unequivocally, that non-smoking employees that work in bars and restaurants where smoking is allowed are mostly exposed to secondhand tobacco smoke at work and that secondhand tobacco smoke exposure during non-working hours is smaller compared to the high levels of exposure found in their work environment. Chile ratified the Framework Convention on Tobacco Control in 2005 but at the time of this research only an incomplete smoking ban was enacted in public places (National Congress of Chile, 2006). Countries, where a total smoking ban has been implemented, have exhibited immediate results in hospitality workers as a substantial reduction in secondhand tobacco smoke exposure (Bondy et al., 2009; Ellingsen et al., 2006) as well as respiratory and sensory symptoms (Larsson et al., 2008). Our findings support that a comprehensive 100% smoke-free legislation, eliminates occupational exposures to secondhand tobacco smoke and protects workers in bars and restaurants.

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