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BRIEF REPORT

Secondhand smoke exposure in bars and restaurants in Guatemala City: before and after smoking ban evaluation

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Abstract
Objective In February 2009, Guatemala implemented a comprehensive smoking ban. We assessed air nicotine levels in bars and restaurants 6 months after the ban (post-ban) and compared them with levels found in 2006 (pre-ban).
Methods Exposure was estimated by passive sampling of vapor-phase nicotine using samplers ($n = 50$) placed for 7 working days in 10 bars and 11 restaurants in Guatemala City. Air nicotine was measured by gas chromatography, and the time-weighted average concentration in $\mu g/m^3$ was estimated. Employees answered a survey about smoke-free workplaces ($n = 32$) and compared with pre-ban ($n = 37$) results.
Results Nicotine was detectable in all bars pre- and post-ban. In restaurants, it was detectable in all pre- and 73% post-ban. Median nicotine concentrations in bars significantly decreased from 4.58 $\mu g/m^3$ (IQR, 1.71, 6.45) pre-ban to 0.28 $\mu g/m^3$ (IQR 0.17, 0.66) post-ban (87% decrease). In restaurants, concentrations significantly decreased from 0.58 $\mu g/m^3$ (IQR, 0.44, 0.71) to 0.04 $\mu g/m^3$ (IQR 0.01, 0.11) (95% decrease). Employees' support for a smoke-free workplace increased in the post-ban survey (from 32 to 81%, $p < 0.001$).
Conclusion Six months after the implementation of a smoke-free law in Guatemala, nicotine levels were significantly decreased in bars and restaurants and workers' support for the law substantially increased.

Keywords Tobacco · Tobacco smoke pollution · Smoke-free environments · Environmental pollution

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Introduction

Secondhand smoke (SHS), the mixture of mainstream and sidestream tobacco smoke, harms children and adults' health [1]. Exposure to SHS is a cause of lung cancer and heart disease [1]. Therefore, the World Health Organization Framework Convention on Tobacco Control (FCTC) mandates countries to "Protect citizens from exposure to tobacco smoke in workplaces, public transport and indoor public places" [2]. Comprehensive smoke-free laws, which include bars and restaurants, are the only measures that guarantee complete protection from SHS exposure. These laws have been shown to result in substantial decrease in heart disease hospitalizations and lung cancer incidence, smoking prevalence, and cigarette consumption [3–6]. For heart disease, the Institute of Medicine has concluded that

there is a causal relationship between smoking bans and decrease in acute myocardial infarction incidence [5]. In addition, respiratory symptoms and inflammatory markers also decrease and respiratory function improves after smoke-free environments are implemented [7].

Guatemala ratified the FCTC on 16 November 2005. In 2006, a new smoke-free law in indoor public places, including bars and restaurants, was presented to Congress. The previous law mandated all establishments that served food to "have separated areas for nonsmokers" [8]. The effort to include bars and restaurants in the new law was supported by evidence documenting high levels of SHS exposure in these venues [9]. In 2006, median bar and restaurant nicotine concentrations were found to be 4.58 and 0.58 $\mu g/m^3$, respectively. Compared to a hospital where the lowest nicotine concentrations were found, levels were 710 and 114 times higher, respectively [9]. These data proved extremely useful to support the inclusion of bars and restaurants in the new law and to educate the general public through mass media and advocacy that exposure to SHS was highest in these public venues [10–13]. As expected, Tabacalera Centro Americana (Philip Morris subsidiary in Guatemala) tried to modify the law to have bars and restaurants exempted [14]. Tabacalera Nacional (British American Tobacco subsidiary) also expressed publicly its opposition to the law and favored a more "reasonable" law such as the one in Spain where the smoking ban was essentially voluntary ([10], [15]). Finally, after a three-year-long political battle, in November 2008 Congress passed Article 74-2008 that enacted comprehensive smoke-free environments, including bars and restaurants in Guatemala. According to this Article, smoking is banned in all workplaces that are surrounded by at least one wall or have a roof. The Ministry of Health is in charge of enforcing the law and imposing fines. After a 60-day "socialization" period, on 20 February 2009, Article 74-2008 was implemented and Guatemala became the third smoke-free country in Latin America after Uruguay in 2006 and Panama in 2008.

Monitoring compliance with the Guatemala smoke-free law is vital to guarantee adequate protection from the harmful effects of SHS and for compliance with the FCTC implementation. Since airborne nicotine concentrations had been measured in bars and restaurants in Guatemala City prior to the smoke-free law implementation (2006), the same protocol could be used to assess compliance post-ban. The objective of this study was to determine air nicotine concentrations in bars and restaurants in Guatemala City 6 months after the implementation of the smoke-free law and to compare them with pre-ban levels. In addition, we compared employees support and attitudes toward the smoke-free law before and after the law.

Methods

This is a cross-sectional SHS exposure survey measuring air nicotine concentrations in bars and restaurants in Guatemala City 6 months (post-ban, August 2009) after the smoke-free law was implemented. We followed the same methodology used in 2006 (pre-ban) to document the need for a smoke-free law [9]. Bars and restaurants were chosen for reassessment in 2009 because these venues had markedly high SHS exposure, and they are the cornerstone to any comprehensive smoke-free law. Because in 2006 the venues were recruited anonymously (to decrease the chance of Hawthorne effect), the exact same venues could not be invited to participate in 2009. From the 22 neighborhoods in which Guatemala City is divided, we recruited venues from neighborhoods 1, 4, 9, 10, 11, and 15. These are where the most popular bars and restaurants are located and where the 2006 sample was drawn from. In both years, to select bars and restaurants, we walked through these neighborhoods and asked for permission to place the monitors using a door-to-door strategy. All bars and restaurants that where opened for business were eligible to participate. Venues were invited to participate without prior knowledge of the level of smoking (2006) or the level of enforcement of the smoke-free law (2009). Out of 12 venues visited in 2006 and 22 venues visited in 2009, 10 and 21 accepted to participate (response rate 80 and 95%; respectively). In both years, measurements were kept anonymous and no bar or restaurant name was recorded. In each venue agreeing to participate, sampling locations were selected to represent areas where people eat or drink (dining area, bar). Permission to place nicotine samplers was obtained from the owner and/or manager. At the time the samplers were placed, bar/restaurant volume (m^3) was estimated by measuring height, width, and length. Information about windows, doors, and mechanical ventilation and/or air conditioning systems was assessed through observation and interviewing the manager/owner. Nicotine samplers were left in place for seven working days. In 2006, 10 samplers were placed in 5 bars (1 sampler lost/stolen) and 10 in 5 restaurants. In 2009, 20 samplers were placed in 10 bars (2 samplers lost/stolen) and 22 in 11 restaurants.

Nicotine was collected using a passive sampler containing a sodium bisulfate-treated filter. The filter was extracted and analyzed at the Exposure Assessment Laboratory of the Institute for Global Tobacco Control at the Johns Hopkins Bloomberg School of Public Health via gas chromatography with nitrogen-selective detection. The 7-day time-weighted average concentration of nicotine in micrograms (μg) per effective volume of air sampled (m^3) was estimated [16]. Volume sampled was calculated by multiplying the sampling time in each location by the

effective sampling rate of the sampler (25 ml/min). For quality control, 10% of monitors were blank/duplicates. Blanks were used to determine the blank-corrected nicotine concentrations and to calculate the nicotine detection limit (0.0074 μg/m^3 for a 7-day sample). The intra-class correlation coefficient between duplicate samples was 0.93.

At the end of the air nicotine sampling, all workers who occupied the bars and restaurants that had been monitored were invited to complete the same questionnaire used in 2006 about attitudes for smoke-free environments and perception of SHS exposure (adapted from Stillman et al. [17]). Thirty-seven workers in 2006 and 32 in 2009 completed the survey and no worker refused to complete the questionnaire in either year. The study protocol was reviewed by the institutional review board of Francisco Marroquín Medical School of Guatemala.

Statistical analysis

Medians and interquartile ranges (IQRs) were used to describe the data, and box plots were used to graphically present the distribution of nicotine concentrations before and after the ban. To compare nicotine concentrations across pre- and post-ban, we computed the crude and adjusted ratio (95% confidence interval) of the post-ban geometric mean of nicotine concentrations versus the pre-ban reference category using linear regression models on log-transformed nicotine. The adjusted ratio accounted for potential differences in public places (bars and restaurants), ventilation, and room volume across the two periods. To compare percentage of respondents' pre- and post-smoking ban that concur with attitudes about smoke-free workplaces, we used a chi-square statistic. Analyses were performed using Stata version 11.0 (Stata Corp, College Station, TX).

Table 1 Bars and restaurants, and nicotine samplers Guatemala City, Guatemala

	2006	2009
Restaurants (*n*)	5	11
No. of samplers placed	10	22
Lost/stolen	0	0
% with nicotine detected	100	73
Bars (*n*)	5	10
No. of samplers placed	10	20
Lost/stolen	1	2
% with nicotine detected	100	100

Results

Airborne nicotine was detected in most bars and restaurants pre-ban and post-ban (Table 1). However, 23% (6 out of 22 samplers) of post-ban restaurants had no detectable levels of nicotine. Median nicotine concentrations in bars markedly decreased from 4.58 μg/m^3 (IQR, 1.71, 6.45) pre-ban to 0.28 μg/m^3 (IQR 0.17, 0.66) post-ban (Table 2 and Fig. 1). In restaurants, it markedly decreased from 0.58 μg/m^3 (IQR, 0.44, 0.71) to 0.04 μg/m^3 (IQR 0.01, 0.11) (Table 2). As in the 2006 monitoring, the highest nicotine concentration was found in a bar. The highest pre-ban level,

Table 2 Air nicotine concentrations in Guatemala City before and after National comprehensive smoke-free legislation

	Pre-ban (2006)			Post-ban (2009)			% GM reduction (95% CI)	
	*n**	Median (IQR)	GM (95% CI)	*n*	Median (IQR)	GM (95% CI)	Crude	Adjusted[a]
Overall	19	0.88 (0.48, 4.80)	1.31 (0.74, 2.29)	40	0.12 (0.04, 0.25)	0.09 (0.05, 0.15)	93 (84, 97)	93 (83, 97)
Public place								
Bar	9	4.58 (1.71, 6.45)	3.02 (1.60, 5.69)	18	0.28 (0.17, 0.66)	0.32 (0.19, 0.53)	90 (76, 96)	87 (69, 95)
Restaurant	10	0.58 (0.44, 0.71)	0.56 (0.32, 1.01)	22	0.04 (0.01, 0.11)	0.03 (0.02, 0.06)	94 (85, 98)	95 (86, 98)
Ventilation[b]								
Natural only	4	2.48 (0.74, 4.80)	1.88 (0.65, 5.41)	10	0.06 (0.05, 0.24)	0.08 (0.04, 0.16)	96 (85, 99)	97 (93, 99)
Mechanical (with/without natural vent.)	15	0.83 (0.45, 4.61)	1.19 (0.62, 2.30)	30	0.13 (0.04, 0.31)	0.09 (0.05, 0.18)	92 (78, 97)	88 (74, 95)
Volume (m^3)								
< 300	13	0.99 (0.46, 5.42)	1.33 (0.62, 2.87)	21	0.17 (0.04, 0.26)	0.11 (0.05, 0.22)	92 (76, 97)	93 (84, 96)
≥ 300	6	0.71 (0.50, 4.19)	1.25 (0.55, 2.85)	19	0.11 (0.04, 0.21)	0.07 (0.03, 0.16)	94 (75, 99)	90 (64, 97)

CI confidence interval, *GM* geometric mean, *IQR* interquartile range

[a] Adjusted for type of public place, ventilation, and room volume

[b] Only one sampler (data not shown) was placed in a location with mechanical ventilation only

* Refers to the number of monitors placed in each venue type

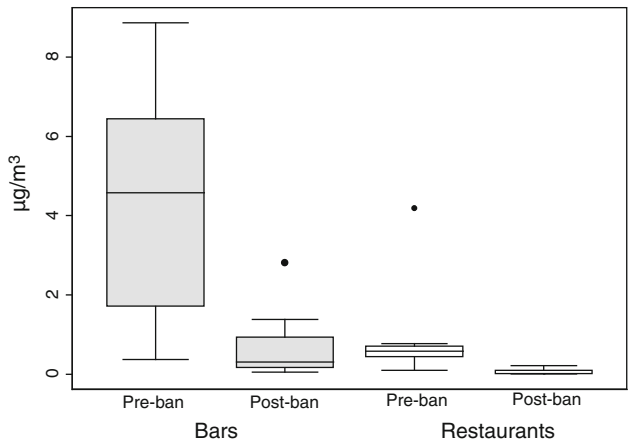

Fig. 1 Pre- and post-ban airborne nicotine concentrations in bars and restaurants in Guatemala City, Guatemala. *Horizontal lines within boxes*, medians; *boxes*, IQR; *bars*, values within 1.5 times the IQR; *solid circles*, outlying points

however, was 8.86 µg/m^3 compared with 1.38 µg/m^3 post-ban. Compared to pre-ban nicotine levels, overall air nicotine concentrations were 93% decreased in the post-ban monitoring (Table 2). The decrease was of 90% and 94% in bars and restaurants, respectively. These percentages remained mostly unchanged after adjustment for ventilation and room volume.

Demographics of pre-ban questionnaire respondents were as follows: mean (SD) age was 27.3 (8.1) years, 82% were men, and 25% were current smokers. The corresponding numbers for post-ban respondents were 30.6 (12.3) years, 66% men, and 27% were current smokers, respectively. Comparing pre- from the post-ban respondents, none of these were significantly different. Employee support for smoke-free environments increased comparing the post-ban to the pre-ban survey. The percentage of employees that agreed that workplaces in general should be smoke-free and that tobacco smoke harms others doubled from 30 to 63% and from 57 to 100% (Table 3). When specifically asked about whether their institution should be smoke-free, the percentage increased by 50%.

Table 3 Percentage of respondents' pre- and post-smoking ban that concur with attitudes about smoke-free workplaces and SHS exposure (Guatemala City, Guatemala)

Bar/restaurant	Pre-ban ($n = 37$)	Post-ban ($n = 32$)	p
Workplaces should be smoke-free	30	63	0.01
My institution should be smoke-free	32	82	<0.001
Tobacco smoke harms others	57	100	<0.001
Smoke ban unfair to others	25	44	0.7

Discussion

Exposure to SHS in bars and restaurants in Guatemala City decreased greatly 6 months after the implementation of a comprehensive smoking ban. The decrease was very high in restaurants; almost one quarter had no detectable levels of nicotine and could be considered completely smoke-free. Bars also showed a dramatic decrease in nicotine levels, even though nicotine was detectable in all bars. The reasons for nicotine still being detected in all bars and many restaurants could be related to incomplete law implementation, compliance and/or enforcement, tobacco smoke drifting from the outside (sidewalks, windows, individuals carrying it in their clothes) and from heavy past exposure, or potentially to employees smoking after hours.

Our data are consistent with findings documented in other countries that have implemented smoking bans. In Ireland, 6 weeks after the ban had been implemented, air nicotine levels in bars had decreased by 83% [18]. Similarly, fine particulate matter (<2.5 µm in diameter, another marker of SHS) decreased on average 90% in Scottish pubs 2 months after the ban had been implemented [19]. In Uruguay, air nicotine concentrations in bars and restaurants decreased 81% 1 year after the implementation of the smoking ban in public places in a 5-year gap study [20]. The consistency of our data with findings from countries with comprehensive legislation and the fact that no other tobacco control measure has been implemented in Guatemala over the same period of time support the hypothesis that the observed decrease is due to the smoking ban. Moreover, it is well documented that in countries without legislation or with partial legislations, there are no noticeable changes in SHS levels over time, including a study in Chile with a 6-year gap before and after the passing of an incomplete smoking ban [21–23].

Employee support for smoke-free environments markedly increased after the implementation of the smoke-free law in Guatemala. Employees agreeing to have their institution smoke-free more than doubled (82% post-ban) compared to pre-ban levels (32%). This increase in support after enacting a comprehensive ban has been documented elsewhere. In Ireland, support increased from 59% pre-ban to 77% one-year after the pub smoking ban had been implemented [24]. Similarly, in California, support increased from 52% pre-ban to 80% 4 years post-ban [25]. The increased popularity of smoking bans among workers who were disproportionately exposed to SHS further supports the feasibility and importance of implementing smoke-free laws in countries similar to Guatemala. While surveys in hospitality employees have not been specifically conducted in Latin America, surveys in general populations

in Mexico and Uruguay suggest that support for smoke-free legislations is generally high and increases with the passing of the legislation [26–28]. Even though not statistically significant, the percentage of employees that agreed that a smoking ban is unfair to others almost doubled from the pre- to the post-ban survey (25 and 44%, respectively). This might be due to employees becoming more aware of smokers having to walk outdoors to smoke.

Our study has strengths and limitations. This is the first study assessing compliance to the smoke-free law in Guatemala. In addition, our conclusions are strengthened by the comparison of pre- and post-ban air nicotine, a highly specific marker of SHS, collected using the same protocol in both periods. Although the venues sampled were not the same in the pre- and post-ban study, they were recruited in the same neighborhoods using a similar approach. Therefore, our results represent an overall decrease in airborne nicotine levels in bars and restaurants recruited post-ban in Guatemala City, the largest city in the country. A range of different SES levels were included, although SES was not specifically part of the selection criteria. In addition, rather than representing a decrease in individual exposure to SHS, this survey analysis yields an overall reduction in SHS exposure in bars and restaurants in Guatemala City. Our sample does not represent any socioeconomic status in particular, but employees are the most likely to benefit from the smoke-free law as they are the ones who spend the longest time in these venues. Even though generalizability of our results is limited to other neighborhoods and towns outside of Guatemala City, it should not affect the validity of our results. Furthermore, other locations that had been monitored in 2006 (hospital, airport, government building, university) were not monitored again in the current study. This decision was based on limited resources, low or very low air nicotine concentrations in those locations already in 2006 and the fact that bars and restaurants were the key location where exposure to SHS was greatest in Guatemala. While this could affect the generalizability of our results to other locations, the internal validity of our study is ensured. The possibility that our results reflect a Hawthorne effect (a modification in smoking behavior as a result that they were being part of the study) is minimal as the samplers are small and almost unnoticeable and they were hanged when the venues were not opened to the public. Moreover, the study was presented mainly as an air pollution study and participation was anonymous. Finally, if there were any Hawthorne effect, it would have been present both in the pre- and post-measurements, minimizing the consequences in the pre- and post-ban comparison.

In conclusion, 6 months after the smoke-free legislation was implemented, SHS exposure levels have greatly decreased in Guatemala City. Regarding cities outside of Guatemala City, preliminary data collected by the San Carlos University Medical School yielded a partial implementation of the law [29]. This might be due to lack of awareness or enforcement by the Ministry of Health. However, more research is warranted on other parts of the country. Over time (and with appropriate enforcement), we should expect SHS levels to continue decreasing even further, especially in bars. Importantly, employee support for the legislation has markedly increased, strengthening ban implementation and enforcement. Our data should help tobacco control advocates and the Ministry of Health in Guatemala to further guarantee workers' protection from SHS exposure. Other countries in the region and worldwide should also be encouraged to measure SHS levels as an effective tool to argue for and support the implementation of comprehensive smoking bans. Finally, additional research is needed to evaluate the impact of the smoke-free law in coronary heart disease and lung cancer incidence in Guatemala.

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