Impact of the Spanish Smoking Law on Exposure to Secondhand Smoke in Offices and Hospitality Venues: Before-and-After Study

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BACKGROUND/OBJECTIVES: A smoking law was passed by the Spanish Parliament in December 2005 and was enforced by 1 January 2006. The law bans smoking in all indoor workplaces but only in some hospitality venues, because owners are allowed to establish a smoking zone (venues > 100 m²) or to allow smoking without restrictions (venues < 100 m²). The objective of the study is to assess the impact of the Spanish smoking law on exposure to secondhand smoke (SHS) in enclosed workplaces, including hospitality venues.

MATERIALS AND METHODS: The study design is a before-and-after evaluation. We studied workplaces and hospitality venues from eight different regions of Spain. We took repeated samples of vapor-phase nicotine concentration in 398 premises, including private offices (162), public administration offices (90), university premises (43), bars and restaurants (79), and discotheques and pubs (24).

RESULTS: In the follow-up period, SHS levels were markedly reduced in indoor offices. The median decrease in nicotine concentration ranged from 60.0% in public premises to 97.4% in private areas. Nicotine concentrations were also markedly reduced in bars and restaurants that became smoke-free (96.7%) and in the no-smoking zones of venues with separate spaces for smokers (88.9%). We found no significant changes in smoking zones or in premises allowing smoking, including discotheques and pubs.

CONCLUSIONS: Overall, this study shows the positive impact of the law on reducing SHS in indoor workplaces. However, SHS was substantially reduced only in bars and restaurants that became smoke-free. Most hospitality workers continue to be exposed to very high levels of SHS. Therefore, a 100% smoke-free policy for all hospitality venues is required.

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The private sector, samplers were placed in the reception area and offices (desk positions). In restaurants, samplers were placed in the main dining room.

We contacted the owners and managers of the selected facilities and venues either by telephone or by letter to explain the details of the study and to request permission. After obtaining permission, we arranged an appointment to place the samplers.

**Vapor-phase nicotine.** We measured vapor-phase nicotine using SHS passive samplers, following the method described and validated by Hammond (1993) and used in previous studies of SHS assessment in Europe (Nebot et al. 2005). The samplers consisted of a 37-mm-diameter plastic cassette containing a filter treated with sodium bisulfate. These samplers were manipulated by instructed personnel according to a common protocol and placed in all the settings studied except pubs and discotheques for 7 days. The samplers that had to hang freely in the air were not placed within 1 m of an area where there was a regular smoker or where air did not circulate (e.g., a corner, under a shelf, or buried in curtains). In discotheques and pubs, where the expected concentration of nicotine was higher and operating hours were mostly at night, we took samples from personal monitors for short periods ranging between 4 and 5 hr. Personal monitors were clipped to a shirt collar or lapel, with the windscreen facing out, away from the clothes. They were carried out by volunteers.

For each sample, we recorded the following data: the sample’s code, region, setting, location, date and time of placement and removal, and smoking policy (smoking allowed, completely banned, or partially banned in separate zones). We recorded information on sampling area, sampling volume, and ventilation in each establishment to evaluate extreme or inconsistent values. We assigned samples with nicotine concentrations below the quantification limit a value of 0.01 μg/m³, corresponding to half the value of quantification limit for one sample exposed over a 1-week period. For quality control purposes, blank filters were placed within sampling filters (1 filter in 20) and all had nicotine concentrations below the quantification limit. Nicotine analysis was conducted at the Laboratory of the Public Health Agency of Barcelona, using the gas chromatography/mass spectrometry method. The limit of quantification was 5 ng per filter. We estimated the time-weighted average nicotine concentration (micrograms per cubic meter) by dividing the amount of extracted nicotine by the volume of air sampled (estimated flow rate (24 mL/min) × the total number of minutes the filter had been exposed).

**Statistical analysis.** We restricted the analysis to places where we took nicotine measurements both at baseline and follow-up (paired samples). Given the skewed distribution of nicotine concentration, we used median and interquartile ranges (IQRs) to describe the nicotine concentration by setting. We compared paired differences using the nonparametric Wilcoxon signed rank test. We used SPSS (version 12.0.1; SPSS, Inc., Chicago, IL, USA) for all the analyses.

**Results**

Overall, we took 443 air samples at baseline in eight regions (autonomous communities) of Spain in the last trimester of 2005. We collected 398 samples (89.8%) again in the same venues at the 12-month follow-up. Table 1 shows the distribution by settings. According to the protocol, we took 162 samples in offices in the private sector, 90 in public administration offices (state, region, and city administration venues), 43 in university indoor premises, 79 in bars and restaurants, and 24 in discotheques and pubs.

Table 2 shows the change in nicotine concentration in workplaces other than hospitality venues at baseline and 12 months after the law was enacted. During the study period, there was a significant reduction in nicotine concentration, ranging from 60% in public administration to 97.4% in private sector offices. After the law, all medians were < 0.20 μg/m³.

Table 3 shows the changes in hospitality sector. The values are stratified according to setting.
to the option taken after the law came into force. We found a significant reduction (96.7%) in places that became smoke-free. In venues allowing a smoking zone, we observed a similar reduction (88.9%) in no-smoking zones, whereas in smoking areas the median concentration increased slightly (37.2%). Venues allowing smoking had a nonsignificant reduction of 19.4%. Discotheques and pubs showed a nonsignificant reduction (from 33.3 to 15.1 μg/m³).

Discussion

Overall, the results confirm the positive impact of the law in the indoor workplaces and hospitality premises that became smoke-free after the law. The median nicotine concentration decreased by 60.0% in public premises and by 97.4% in private workplaces. A major reduction (96.7%) also occurred in bars and restaurants that became smoke-free and in the no-smoking zones of venues where separate spaces were allowed (88.9%). In smoking zones and in premises allowing smoking, including discotheques and pubs, no significant changes occurred. As expected, the presence of SHS in bars allowing smoking, and in the smoking zones of those permitting separate zones, remained extremely high. Regarding differences in the proportions and nicotine levels between regions, stratifying by region, type of venue, and smoking regulation, the sample size in each stratum is too small to make statistically reliable comparisons.

The results of our study are consistent with those of previous studies that use nicotine in the air to evaluate the impact of smoking regulations. This method has proven to be both valid and sensitive and is therefore able to monitor changes in smoking policies with just a few samples. For example, seven discotheques and pubs were analyzed in Italy by Gorini et al. (2005), and 20 bars and pubs were studied in Ireland by Mulcahy et al. (2005). These studies found reductions in nicotine concentrations from 80% to 95% in bars that became smoke-free—percentages close to those found in our study.

Studies using other indicators have also detected changes. Some of these studies have used either other airborne markers such as particulate matter with aerodynamic diameters ≤ 2.5 μm (Goodman et al. 2007; Repace et al. 2006; Semple et al. 2007a; Valente et al. 2007) or biomarkers such as cotinine in saliva (Allwright et al. 2005; Semple et al. 2007b), and all have reported results very similar to ours. Furthermore, some of these studies used questionnaires to measure SHS exposure (Fong et al. 2006; Galán et al. 2007; Haw and Gruer 2007), although these studies cannot fully rule out some information bias.

A limitation common to many of the studies evaluating the impact of smoking policies is the short interval considered after the ban, in most cases only some weeks or months after the law was introduced. Only a few (Allwright et al. 2005; Goodman et al. 2007) have looked at the indicators 1 year after the law was enacted. As far as we know, only one study carried out in Italy (Gorini et al. 2008) evaluated the impact of the smoking policy 2 years after the implementation, showing an important decrease in nicotine concentrations even 2 years after the smoking ban. However, more studies are needed to rule out a possible “decay” effect of the smoking policies over the time.

This is the first study to show the impact of the Spanish law on SHS by using airborne markers and is among the few studies showing changes both in indoor workplaces and in hospitality sector venues. We have studied nearly 400 air samples, thus yielding by far the largest sample used in this kind of study. In pubs and discotheques, filters were exposed for shorter periods (4–5 hr) than in other settings, which may have impaired comparability with other settings. However, we chose these time periods because typically these venues have most clients on the weekends and some are open only at this time. Therefore, exposing a filter for a whole week would have underestimated the real exposure. Because nicotine concentrations in these settings during working hours is very high (López et al. 2004, 2008; Nebot et al. 2005), a minimum of 4 hr is sufficient to detect the presence of nicotine above the minimum detection limit. We made measurements using the same procedure both sampling periods (before and after measurements), thus ensuring accurate estimation of changes in nicotine concentrations.

Another possible limitation could be the absence of a control group. However, control groups in evaluative public health research are not always necessary (or even possible) due to the complexities of the interventions evaluated (Victora et al. 2004). In this case, the characteristics of the law regarding the hospitality sector (i.e., permitting bars to choose between being smoke-free or non-smoke-free) allow the possibility of having two groups with different behaviors after the law, enabling comparison between hospitality premises that allow smoking and those that were smoke-free. Furthermore, the present study is a before-and-after study, in which comparison between the measurements taken before and after the law provide a valid and reliable estimate of the impact of the law. Overall, this study shows the positive impact of the law in reducing SHS in indoor workplaces such as offices and provides a precise description of the law’s lack of effect in the hospitality venues that did not become smoke-free—a result that was largely anticipated by tobacco control advocates (Córdoba et al. 2006). In addition, this study shows the strong impact of smoke-free policies in the air of the few bars and restaurants banning smoking. In terms of public health, a large reduction in exposure has been achieved. However, workers in the hospitality sector remain exposed to very high levels of SHS, and therefore the situation cannot be considered satisfactory.

Assuming that approximately 80% (Martín-Luengo 2007) of hospitality workers in Spain (1,400,000) (Instituto Nacional de Estadística de Salud) had their workplace indoor air nicotine concentrations measured (from 33.3 to 15.1 μg/m³).

Table 2. Median nicotine concentration (μg/m³) in workplaces at baseline and at the 12-month follow-up.

| Setting                | Median nicotine concentration (IQR) | Baseline | 12-month follow-up | Percent variation | p-Value* |
|------------------------|-------------------------------------|----------|--------------------|------------------|----------|
| Public administration  | 0.20 (0.06–0.57)                    | 0.06 (0.01–0.18) | –60.0             | < 0.001         |
| Local administration   | 0.46 (0.12–1.13)                    | 0.13 (0.03–0.20) | –71.7             | 0.006         |
| Regional administration| 0.12 (0.06–0.38)                    | 0.08 (0.01–0.20) | –33.3             | 0.020         |
| National administration| 0.20 (0.06–0.64)                    | 0.05 (0.01–0.11) | –75.0             | < 0.001         |
| Universities           | 0.21 (0.08–0.50)                    | 0.07 (0.01–0.15) | –66.7             | < 0.001         |
| Private sector         | 0.39 (0.07–1.28)                    | 0.01 (0.01–0.16) | –97.4             | < 0.001         |
| Small (<10 workers)    | 0.41 (0.05–1.40)                    | 0.06 (0.01–0.18) | –85.4             | < 0.001         |
| Medium (10–50 workers) | 0.39 (0.08–1.30)                    | 0.01 (0.01–0.15) | –97.4             | < 0.001         |

*Wilcoxon signed-rank test.

Table 3. Median nicotine concentration (μg/m³) in hospitality venues at baseline and at the 12-month follow-up.

| Setting                  | Median nicotine concentration (IQR) | Baseline | 12-month follow-up | Percent variation | p-Value* |
|--------------------------|-------------------------------------|----------|--------------------|------------------|----------|
| Bars/Restaurants         |                                     |          |                    |                  |          |
| Smoking banned           | 2.71 (1.39–3.77)                    | 0.09 (0.01–0.26) | –96.7             | < 0.001         |
| Smoking permitted throughout the premises | 7.07 (1.86–11.78) | 5.70 (2.77–11.73) | –19.4             | 0.191         |
| Smoking permitted in designated areas | 5.58 (2.42–12.42) | 8.99 (5.28–15.61) | 37.2              | 0.075         |
| Non-smoking area         | 5.58 (2.42–12.42)                   | 0.62 (0.34–1.40) | –88.9             | 0.036         |
| Discotheques/pubs       |                                     |          |                    |                  |          |
| Smoking allowed          | 33.31 (10.79–79.65)                 | 15.06 (6.77–56.92) | –54.79            | 0.241         |

*Wilcoxon signed-rank test. *Smoking regulation after the law; at baseline, smoking was permitted in all venues.
2006) are still working in non-smoke-free hospitality venues and that the median nicotine concentration found in those venues in our study is associated with an excess lung cancer mortality risk of 98 per 100,000 (Repace and Lowrey 1993), the impact in terms of mortality burden could be as high as 1,000 deaths in hospitality-sector workers, if regularly exposed to this level of SHS for 40 years. Clearly, the results support a complete ban on smoking in all indoor places, including hospitality sector venues.

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