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BRIEF REPORT

Impact of the 2011 Spanish Smoking Ban in Hospitality Venues: Indoor Secondhand Smoke Exposure and Influence of Outdoor Smoking

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ABSTRACT

Introduction: The Spanish tobacco control law of 2006 was modified in January 2011, banning smoking in all hospitality venues. The objective of the study was to assess the impact of the 2011 Spanish smoking ban on secondhand smoke (SHS) exposure in hospitality venues, and to analyze the potential impact of outdoor smokers close to entrances on indoor SHS levels after the law came into force.

Methods: Before-and-after evaluation study with repeated measures. The study was carried out in three regions of Spain (Catalonia, Galicia, and Madrid) and included a random sample of 178 hospitality venues. We measured vapor-phase nicotine and particulate matter 2.5 micrometers or less in diameter (PM2.5) as SHS markers at baseline (November–December 2010) and at follow-up (April–June 2011). We also recorded tobacco consumption variables such as the presence of butts, ashtrays, and smokers. In the posttest assessment, we also recorded the number of outdoor smokers close to the entrance.

Results: A total of 351 nicotine and 160 PM2.5 measurements were taken. Both nicotine and PM2.5 concentrations decreased by more than 90% (nicotine from 5.73 to 0.57 $\mu g/m^3$, PM2.5 from 233.38 to 18.82 $\mu g/m^3$). After the law came into force, both nicotine and PM2.5 concentrations were significantly higher in venues with outdoor smokers close to the entrance than in those without outdoor smokers. All the observational tobacco consumption variables significantly decreased ($p < .001$).

Conclusions: SHS exposure in hospitality venues dramatically decreased after the 2011 Spanish smoking ban. SHS from outdoor smokers close to entrances seems to drift inside venues. Smoking control legislation should consider outdoor restrictions to ensure complete protection against SHS.

INTRODUCTION

Secondhand smoke (SHS) exposure has been causally associated with numerous health effects such as lung cancer, cardiovascular disease, and respiratory symptoms (U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2006). Consequently, numerous countries have implemented tobacco control laws in the last decade, banning smoking in indoor workplaces and public settings. Hospitality venues have remained the exception in some countries, despite cumulative evidence showing that indoor smoking bans are highly effective in protecting workers and clients from SHS exposure (IARC, 2009).

In January 2006, a tobacco control law came into force in Spain, banning smoking in all workplaces except for hospitality venues, where partial restrictions were applied depending

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on the size of the venue. Several studies have assessed the impact of this law on SHS levels and found that hospitality workers were still exposed to extremely high levels of SHS after the implementation of the law (Fernandez et al., 2009; Galan et al., 2007; Lopez et al., 2012; Manzanares-Laya et al., 2011; Nebot et al., 2009). Consequently, the Spanish smoking law was modified, banning indoor smoking in all hospitality venues since January 2011. A side effect of the indoor smoking bans has been the displacement of smokers outdoors, usually close to the entrances of venues. Outdoor SHS assessment may be important, since SHS can drift to adjacent indoor areas, exposing people who remain inside. For this reason, outdoor SHS has become a growing public health concern in recent years (Brennan et al., 2010; Cameron et al., 2010; Kaufman et al., 2011; Sureda et al., 2012).

The objective of this study was to assess the impact of the 2011 Spanish tobacco control law on SHS exposure in hospitality venues and to analyze the potential impact of smoking close to entrances on the indoor SHS levels after the law came into force.

METHODS

We carried out a before-and-after evaluation study with repeated measures in three distinct regions of Spain: Catalonia, Galicia, and Madrid. We selected the hospitality venues by following a multistage design. The first stage involved randomly selecting a sample of districts and census tracts weighted by population size. Second, a random sample of venues was selected of all venues located in census tracts sampled in the first stage. We excluded fast food venues and musical night bars and restaurants without bar service. Hospitality venues where smoking was already banned before the law and venues with less than three clients at the time of measurement were also excluded from the study. A total sample of 178 venues was included in the study, with measurements at baseline (November–December 2010) and at follow-up (April–June 2011). Measurements at each venue were taken on the same type of day (working day/weekend) and during the same range of hours (morning/afternoon).

Study Variables

We measured environmental nicotine in all hospitality venues included in the study, while particulate matter 2.5 micrometers or less in diameter (PM2.5) was measured in a subsample of venues, since particulate matter (PM) monitors were not available for all the geographic areas. Nicotine and PM2.5 measurements were taken simultaneously and positioned at the same location (approximately in the middle of the venue). All the measurements were taken undercover without asking for permission.

We measured vapor-phase nicotine using environmental tobacco smoke samplers, following Hammond's validated method (Hammond, 1993). Briefly, the sampler consisted of a 37–mm diameter plastic cassette containing a filter treated with sodium bisulphate. The samplers were attached to an air pump with a flow rate of 3 L/min, and 30–min measurements were taken. The nicotine analysis was conducted at the Laboratory of the Public Health Agency of Barcelona by the gas chromatography/mass spectrometry method. The limit of quantification was 5 ng/filter. Samples with values under the limit of quantification were assigned half of this value. We estimated the time-weighted average nicotine concentration (μg/m^3) by dividing the amount of extracted nicotine with the volume of air sampled (estimated flow rate multiplied by the total number of minutes the filter had been exposed).

We measured PM2.5 using TSI SidePak AM510 Personal Aerosol Monitors. We adjusted all the measurements according to the calibration factor derived for each monitor in an experimental study (Ruprecht et al., 2011), calibrating the monitors against a BAM-1020 instrument that measured airborne particulate concentrations by using the principle of beta-ray attenuation. Thirty–minute measurements were taken in each venue. We downloaded the recorded measurements to a personal computer for analysis.

For each nicotine and PM2.5 measurement, we recorded the following data: the sample's code, city, date, starting and ending time of the measure, presence of ashtrays, presence of butts (including butts in ashtrays, on the floor, and in any other place inside the venue), and the number of smokers. To assess the number of smokers, we recorded the number of people smoking close (around 1 m maximum) to the door (independently of the presence of a patio or terrace) at minutes 1, 15, and 30 of the measurement. In the measurements carried out after the law, we also recorded the number of smokers outdoors. This variable was only measured during the measurements taken at follow-up in order to assess the potential impact of outdoor smokers on indoor SHS levels after the implementation of the indoor smoking ban. Finally, we recorded information on the sampling area, sampling volume, and ventilation in each establishment to evaluate extreme or inconsistent values.

Statistical Analysis

Given the skewed distribution of PM2.5 and nicotine concentrations, we used medians and interquartile ranges to describe the data. We used the Wilcoxon and Mann–Whitney *U* tests to compare medians and Mc Nemar test for nominal data, according to the dependent or independent nature of the samples, at a 5% significance level. Analyses were performed using SPSS 18.0.

RESULTS

All the observational tobacco consumption variables recorded were significantly reduced ($p < .001$), comparing before and after the implementation of the 2011 smoke-free legislation. (Table 1). The decrease was especially marked in the presence of ashtrays and butts. Both nicotine and PM2.5 concentrations decreased by more than 90% ($p < .001$). The median nicotine concentration decreased from 5.73 μg/m^3 at baseline to 0.57 μg/m^3 after the law came into force ($p < .001$), while the median PM2.5 concentration decreased from 233.38 to 18.82 μg/m^3 ($p < .001$). Finally, nicotine and PM2.5 concentrations after the law were significantly higher in venues where there were outdoor smokers close to the entrance ($p < .001$ and $p < .05$, respectively). The median nicotine concentration found after the law in those venues with outdoor smokers close to the door was 1.13 μg/m^3, while the concentration found in those venues without smokers was 0.41 μg/m^3. No significant differences

Table 1. Observational Tobacco Consumption Variables, Nicotine and PM2.5 Concentration (μg/m^3) at Baseline (November–December 2010) and Follow-up (April–May 2011) in 178 Hospitality Venues in Spain

	Baseline	Follow-up	Relative percentage of change	
Environmental SHS markers	Median [IQR]	Median [IQR]	(%)	*p* value[a]
Nicotine (n = 171 paired samples)	5.73 [2.63–12.49]	0.57 [0.22–1.27]	−90.05	<.001
Smokers outdoor postlaw[c]				
Yes (n = 60)		1.13 [0.39–1.87]		
No (n = 109)		0.41 [0.17–0.83]		
p value[d]		<.001		
PM (n = 80 paired samples)	233.38 [123.93–385.05]	18.82 [13.26–28.05]	−91.93	<.001
Smokers outdoor postlaw[c]				
Yes (n = 22)		24.74 [19.28–33.15]		
No (n = 57)		16.32 [12.24–22.95]		
p value[d]		<.05		
Observational tobacco consumption variables	*N* (%)	*N* (%)	(%)	*p* value[b]
Presence of ashtrays	170 (95.5)	1 (0.6)	−99.41	<.001
Presence of butts	137 (77.0)	0 (0.0)	−100.00	<.001
Presence of indoor smokers	167 (93.8)	7 (4.1)	−95.80	<.001

Note. IQR = interquartile range; PM = particulate matter; PM2.5 = particulate matter 2.5 micrometers or less in diameter; SHS = secondhand smoke.
[a]Wilcoxon test, comparison baseline versus follow-up.
[b]McNemar X^2 test, comparison baseline versus follow-up.
[c]Presence of outdoor smokers close to the main entrance at follow-up. The presence of outdoor smokers was only recorded at follow-up and therefore the baseline and follow-up nicotine and PM2.5 concentrations are shown according to this variable measured at follow-up.
[d]Mann–Whitney *U* test, comparison "outdoor smokers postlaw" versus "no outdoor smokers postlaw."

were found between those venues at the baseline (data not shown).

DISCUSSION

Our study shows that SHS exposure in hospitality venues has been dramatically reduced after the 2011 Spanish smoking ban. Furthermore, our data show that the presence of smokers outdoors but close to the entrance increases indoor SHS exposure in comparison with venues without the presence of smokers outdoors.

The 90% decrease found in nicotine and PM2.5 levels after the law is consistent with the results of other evaluation studies of European smoking control laws banning smoking in hospitality venues. Semple, Creely, Naji, Miller, and Ayres, (2007), for instance, found an 86% reduction in PM2.5 concentration in Scottish pubs after the smoking ban. Similar reductions (83%) were found for PM2.5 (Goodman, Agnew, McCaffrey, Paul, & Clancy, 2007) and nicotine (Mulcahy, Evans, Hammond, Repace, & Byrne, 2005) in hospitality venues after the implementation of the Irish smoking control law. Furthermore, these results are also consistent with other laws recently evaluated in other countries out of Europe like Uruguay (Blanco-Marquizo et al., 2010), where an overall nicotine reduction of 91% was found after the implementation of the law. It is noteworthy that these important reductions on SHS are only observed with comprehensive legislations, while partial legislations such as the previous Spanish law (López et al., 2012; Nebot et al., 2009) or the current Chilean law (Erazo et al., 2010) are not successful in protecting workers and customers from the SHS exposure.

The results of our study also show that outdoor SHS seems to drift to adjacent indoor areas, pointing to the fact that outdoor smoking might reduce the effectiveness of the indoor smoking bans at protecting hospitality workers and patrons from exposure to SHS. This finding is consistent with previous studies assessing outdoor SHS levels (Kaufman et al., 2011; Sureda et al., 2011). One of these studies (Sureda et al., 2011), carried out in public buildings in Spain, showed that PM2.5 concentrations simultaneously measured in the main outdoor entrances of public buildings and in adjacent indoor halls were similar and were higher than control points located outdoors and indoors.

A potential limitation of our study is that it was carried out in only three regions of Spain. However, these regions included rural and urban areas, representing different cultural and socioeconomic contexts. In addition, PM2.5 concentrations were not measured in all the venues selected due to logistic difficulties (i.e., the limited number of PM monitors). However, nicotine, the marker measured in all the venues, is extremely sensitive and specific, with no other natural sources of nicotine in the air except SHS. Finally, seasonality might have influenced the difference found in SHS levels between baseline and follow-up since baseline measurements were taken in winter, while the follow-up measurements were taken in spring, when windows and doors were more likely to be open. However, we recorded observational variables of tobacco consumption—such as the number of indoor smokers or the presence of butts—and all decreased after the smoking ban, showing that the reduction in SHS is likely to have been mainly due to lower tobacco consumption.

This is the first study evaluating the impact of the 2011 Spanish smoking law on SHS levels using two different airborne markers. The selection of venues followed a multistage sampling design with random selection, which would minimize potential selection bias and facilitate generalization of the results. Finally, a high follow-up rate (95% for nicotine and 100% for PM measurements) was achieved, ensuring unbiased assessment of changes in SHS.

Overall, this study shows the positive impact of the 2011 Spanish tobacco control law in reducing SHS exposure in hospitality venues. Modification of the 2006 law has dramatically reduced the risk for both hospitality workers and customers. However, smokers were found in 4% of the venues studied after the law, showing that there is still room for improvement and that further surveillance and monitoring are needed. Finally, another important finding of our study was that indoor nicotine concentrations after the law were significantly higher in venues with outdoor smokers than in those without. In view of these results, smoking control legislation should consider including some outdoor restrictions to ensure complete protection against SHS.

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DECLARATION OF INTERESTS

None declared.

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REFERENCES

Blanco-Marquizo, A., Goja, B., Peruga, A., Jones, M. R., Yuan, J., Samet, J. M., . . . Navas Acien, A. (2010). Reduction of secondhand tobacco smoke in public places following national smoke-free legislation in Uruguay. *Tobacco Control*, *19*, 231–234. doi:10.1136/tc.2009.034769

Brennan, E., Cameron, M., Warne, C., Durkin, S., Borland, R., Travers, M. J., . . . Wakefield, M. A. (2010). Secondhand smoke drift: Examining the influence of indoor smoking bans on indoor and outdoor air quality at pubs and bars. *Nicotine & Tobacco Research*, *12*, 271–277. doi:10.1093/ntr/ntp204

Cameron, M., Brennan, E., Durkin, S., Borland, R., Travers, M. J., Hyland, A., . . . Wakefield, M. A. (2010). Secondhand smoke exposure (PM2.5) in outdoor dining areas and its correlates. *Tobacco Control*, *19*, 19–23. doi:10.1136/tc.2009.030544

Erazo, M., Iglesias, V., Droppelmann, A., Acuña, M., Peruga, A., Breysse, P. N., & Navas-Acien, A. (2010). Secondhand tobacco smoke in bars and restaurants in Santiago, Chile: Evaluation of partial smoking ban legislation in public places. *Tobacco Control*, *19*, 469–474.

Fernández, E., Fu, M., Pascual, J. A., López, M. J., Pérez-Ríos, M., Schiaffino, A., . . . Spanish Smoking Law Evaluation Group. (2009). Impact of the Spanish smoking law on exposure to second-hand smoke and respiratory health in hospitality workers: A cohort study. *PLoS One*, *4*, e4244. doi:10.1371/journal.pone.0004244

Galán, I., Mata, N., Estrada, C., Díez-Gañán, L., Velázquez, L., Zorrilla, B., . . . Ortiz, H. (2007). Impact of the "Tobacco control law" on exposure to environmental tobacco smoke in Spain. *BMC Public Health*, *7*, 224. doi:10.1186/1471-2458-7-224

Goodman, P., Agnew, M., McCaffrey, M., Paul, G., & Clancy, L. (2007). Effects of the Irish smoking ban on respiratory health of bar workers and air quality in Dublin pubs. *American Journal of Respiratory and Critical Care Medicine*, *175*, 840–845. doi:10.1164/rccm.200608-1085OC

Hammond, S. K. Evaluating exposure to environmental tobacco smoke. (1993) In E. D. Winegar & L. H. Keith (Eds.). *Sampling and analysis of airborne pollutants* (pp. 319–337). Boca Raton, FL: CRC Press.

IARC Handbooks of Cancer Prevention. (2009). *Evaluating the effectiveness of smoke-free policies* (Vol. *13*). Lyon. Retrieved from www.iarc.fr/en/publications/pdfs-online/prev/handbook13/handbook13.pdf

Kaufman, P., Zhang, B., Bondy, S. J., Klepeis, N., & Ferrence, R. (2011). Not just 'a few wisps': real-time measurement of tobacco smoke at entrances to office buildings. *Tobacco Control, 20,* 212–218.

López, M. J., Nebot, M., Schiaffino, A., Pérez-Ríos, M., Fu, M., Ariza, C., . . . Spanish Smoking Law Evaluation Group. (2012). Two-year impact of the Spanish smoking law on exposure to secondhand smoke: Evidence of the failure of the 'Spanish model'. *Tobacco Control*, *21*, 407–411. doi:10.1136/tc.2010.042275

Manzanares-Laya, S., López, M. J., Sánchez-Martínez, F., Fernández, E., & Nebot, M. (2011). Impact of the 28/2005 Spanish smoking law on second-hand smoke exposure in Barcelona. *Gaceta Sanitaria*, *25*, 495–500. doi:10.1016/j.gaceta.2011.06.006

Mulcahy, M., Evans, D. S., Hammond, S. K., Repace, J. L., & Byrne, M. (2005). Secondhand smoke exposure and risk following the Irish smoking ban: An assessment of salivary cotinine concentrations in hotel workers and air nicotine levels in bars. *Tobacco Control*, *14*, 384–388. doi:10.1136/tc.2005.011635

Nebot, M., López, M. J., Ariza, C., Pérez-Ríos, M., Fu, M., Schiaffino, A., . . . Spanish Smoking Law Evaluation Group. (2009). Impact of the Spanish smoking law on exposure to secondhand smoke in offices and hospitality venues: Before-and-after study. *Environmental Health Perspectives*, *117*, 344–347. doi:10.1289/ehp.11845

Ruprecht, A. A., De Marco, C., Boffi, R., Mazza, R., López, M. J., & Moshammer, H. (2011). Mass calibration and relative humidity compensation requirements for optical portable particulate matter monitors: the IMPASHS (Impact of Smoke-free Policies in EU Member States) WP2 preliminary results. *Epidemiology*, *22*, s206. doi:10.1097/01.ede.0000392314.24613.c6

Semple, S., Creely, K. S., Naji, A., Miller, B. G., & Ayres, J. G. (2007). Secondhand smoke levels in Scottish pubs: The effect of smoke-free legislation. *Tobacco Control*, *16*, 127–132. doi:10.1136/tc.2006.018119

Sureda, X., Martínez-Sánchez, J. M., López, M. J., Fu, M., Agüero, F., Saltó, E., . . . Fernandez, E. (2011). Secondhand smoke levels in public building main entrances: Outdoor and indoor PM2.5 assessment. *Tobacco Control*. doi:10.1136/tobaccocontrol-2011–050040

U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, & Office on Smoking and Health. (2006). The health consequences of involuntary exposure to tobacco smoke: A report of the surgeon general. Retrieved from www.surgeongeneral.gov/library/secondhandsmoke/