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Italy and Austria before and after study: second-hand smoke exposure in hospitality premises before and after 2 years from the introduction of the Italian smoking ban

Abstract The aim of this paper was to compare nicotine concentration in 28 hospitality premises (HPs) in Florence and Belluno, Italy, where a smoking ban was introduced in 2005, and in 19 HPs in Vienna, Austria, where no anti-smoking law entered into force up to now. Airborne nicotine concentrations were measured in the same HPs in winter 2002 or 2004 (pre-ban measurements) and winter 2007 (post-ban measurements). In Florence and Belluno, medians decreased significantly ($P < 0.001$) from 8.86 [interquartile range (IQR): 2.41–45.07)] before the ban to 0.01 $\mu g/m^3$ (IQR: 0.01–0.41) afterwards. In Austria (no smoking ban) the medians collected in winters 2004 and 2007 were, respectively, 11.00 (IQR: 2.53–30.38) and 15.76 $\mu g/m^3$ (IQR: 2.22–31.93), with no significant differences. Measurements collected in winter 2007 in 28 HPs located in Naples, Turin, Milan (0.01 $\mu g/m^3$; IQR: 0.01–0.16) confirmed post-ban results in Florence and Belluno. The medians of nicotine concentrations in Italy and Austria before the Italian ban translates, using the risk model of Repace and Lowery, into a lifetime excess lung cancer mortality risk for hospitality workers of 11.81 and 14.67 per 10,000, respectively. Lifetime excess lung cancer mortality risks for bar and disco–pub workers were 10–20 times higher than that calculated for restaurant workers, both in Italy and Austria. In winter 2007, it dropped to 0.01 per 10,000 in Italy, whereas in Austria it remained at the same levels. The drop of second-hand smoke exposure indicates a substantial improvement in air quality in Italian HPs even after 2 years from the ban.

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Practical Implications
The nation-wide smoking ban introduced in Italy on January 10, 2005, resulted in a drop in second-hand smoke exposure in hospitality premises, whereas in Austria, where there is no similar nation-wide smoking ban, the exposure to second-hand smoke in hospitality premises remains high. Given that second-hand smoke is considered a group 1 carcinogen according to the International Agency for Research on Cancer classification, the World Health Organization Framework Convention on Tobacco Control strongly recommends the implementation of nation-wide smoke-free policies in order to improve the indoor air quality of hospitality premises and workplaces. Results from our study strongly supports this recommendation.

Introduction

Smoking bans or smoking restriction laws in workplaces and/or hospitality premises (HPs) have been introduced in a growing number of countries in Europe [Ireland, Norway, Italy (Republic of Italy,2003a,b), Malta, Sweden, Spain, Finland, Scotland, Belgium, Northern Ireland, France, and UK] (Spinney, 2007). The introduction of smoke-free legislation has been shown to dramatically reduce second-hand smoke (SHS) levels in hospitality sector. After the implementation of the Irish ban, in 20 pubs in Galway airborne nicotine concentration reduced by 83%, from 35.52 to 5.95 $\mu g/m^3$ (Mulcahy et al., 2005), and in 42 pubs in Dublin particulate matter 2.5 μm or smaller (PM2.5) decreased from 35.5 to 5.8 $\mu g/m^3$, whereas benzene concentration decreased from 18.8 to 3.7 $\mu g/m^3$ (Goodman et al., 2007). After the implementation of the ban in Norway, total dust level in 13 bars and restaurants fell from 262 to 77 $\mu g/m^3$, a 70% reduction (Ellingsen et al., 2006). PM2.5 levels before the introduction of the Scottish legislation averaged 246 $\mu g/m^3$ in 41 pubs in Aberdeen and Edinburgh; afterwards it drop to 20 $\mu g/m^3$, a 86% reduction (Semple et al., 2007). Similar studies were conducted after nation-wide or city-wide smoking bans also in Delaware (Repace, 2004), New York State (Travers et al., 2004), Boston, Massachusetts (Repace et al., 2006), and Austin, Texas (Waring and Siegel, 2006). After the Italian smoking ban, Airborne nicotine concentration in seven discos/pubs in Florence reduced by 97% immediately after the introduction of the Italian smoking ban, from 149.13 to 4.83 $\mu g/m^3$ (Gorini et al., 2005). PM2.5 concentration in two restaurants and two pubs in Milan immediately after the smoking ban (Ruprecht et al., 2006), in six bars in Trieste (Tominz et al., 2006) and in 40 HPs in Rome (Valente et al., 2007) after 1 year from the ban, reduced by approximately 60–90% as well.

To report changes in SHS exposure levels in a larger sample of Italian HPs located in different regions, to assess the long-term (2 years) impact of the ban, and to compare pre- and post-ban Italian measures with those collected in the same periods in a country where no anti-smoking law entered into force up to now, we conducted the 'Italy & Austria Before and After Study'. This study compared nicotine concentrations in HPs and lifetime excess lung cancer mortality risks for hospitality workers, in Florence and Belluno, Italy, and in Vienna, Austria, before and after 2 years from the introduction of the Italian ban, using Austria as the control country, to control for unrelated secular trend. We also collected post-ban measurements in Milan, Turin, Naples, to validate post-ban measurements collected in Florence and Belluno, and to provide an overall picture of the impact of the ban in Italy.

Materials and methods

Design and population

Florence and Belluno measurements. To compare nicotine concentrations before and after the introduction of the Italian smoking ban, we collected 58 pre-ban and 59 post-ban measurements in the same HPs: eight restaurants, 12 discos/pubs, and one bar in Florence; two restaurants, three disco/pubs, and two bars in Belluno. Pre-ban measurements of six restaurants and five discos/pubs in Florence were collected in winter 2002 for a multicenter study on SHS exposure in public places in six European cities (Nebot et al., 2005). The other pre-ban measurements were sampled in winter 2004 for a multicenter study on SHS exposure in HPs and workplaces in eight European towns (Gasparrini et al., 2006; Nebot and Lopez, 2004). Post-ban measures were collected in the same HPs in winter 2007.

Vienna measurements. To do a similar comparison in a nation with no smoking ban, we collected 46 measurements in nine restaurants, six discos/pubs, and four bars, in Vienna, Austria, in winter 2004 (Nebot and Lopez, 2004), and 47 measurements in the same HPs in winter 2007 (Table 1).

Naples, Turin, Milan measurements. To validate post-ban measurements from Florence and Belluno, in winter 2007 we collected 52 post-ban measurements in 15 restaurants and 12 discos/pubs in Turin, Milan, Naples, where pre-ban measurements were not available (Table 2).

Table 1 Nicotine concentrations in hospitality premises in Italy (Florence, Belluno) and Austria (Vienna) before and after the Italian smoking ban

	Before the Italian smoking ban (winter 2002 or 2004)		After the Italian smoking ban (winter 2007)		
Setting (no. of premises)	No. of samples	Nicotine concentration	No. of samples	Nicotine concentration	*P*-value[a]
Austria					
Restaurants (9)	23	2.53 (0.88–10.46)	23	2.57 (0.37–8.21)	0.965
Discos and pubs (6)	14	24.31 (11.53–30.38)	15	28.24 (15.10–41.67)	0.921
Bars (4)	9	49.60 (21.66–59.67)	9	31.43 (17.81–37.44)	0.145
Overall (19)	46	11.00* (2.53–30.38)	47	15.76* (2.22–31.93)	0.681
Italy					
Restaurants (10)	22	2.03 (0.93–4.17)	21	0.10 (0.01–0.18)	<0.001
Discos and pubs (15)	30	35.16 (11.52–134.62)	31	0.01 (0.01–3.21)	<0.001
Bars (3)	6	19.02 (1.72–45.07)	7	0.25 (0.01–0.30)	0.003
Overall (28)	58	8.86* (2.41–45.07)	59	0.01* (0.01–0.41)	<0.001

Values of nicotine concentration ($\mu g/m^3$) are medians (interquartile ranges).
[a]*P*-value for comparison of differences (Wilcoxon rank sum test).
*Medians of the overall distributions of nicotine concentrations.

Table 2 Nicotine concentrations in hospitality premises after the Italian smoking ban in restaurants and discos and pubs in Milan, Turin, Naples

	After the Italian smoking ban	
Setting (No. of premises)	No. of samples	Nicotine concentration
Restaurants (15)	29	0.01 (0.01–0.14)
Discos and Pubs (12)	23	0.01 (0.01–6.15)
Overall (27)	52	0.01* (0.01–0.16)

Values of nicotine concentration ($\mu g/m^3$) are medians (interquartile ranges).
*Medians of the overall distributions of nicotine concentrations.

As a rule, we collected 2–3 samples per hospitality venue and, for premises with pre- and post-ban measurements, per period (pre- and post-ban). Settings were sampled at random when a sampling universe list was available and no other selection criteria prevailed (Nebot et al., 2005). In Italy, no sampled HPs after the ban had a separated smoking room, as the Italian ban provided (Republic of Italy, 2003a,b).

Nicotine measurements

Nicotine vapour-phase concentration was measured using passive samplers, following the method validated by Hammond et al. (1993) and used in several studies in USA, Latin America, and Europe (Hammond et al., 1995; Navas-Acien et al., 2004; Nebot et al., 2005). The samplers comprise a plastic cassette (with a windscreen in one side), containing a filter treated with sodium bisulfate (diameter of 37 mm). Environmental samplers were used to collect samples in restaurants and bars. Samplers were placed for a period of 1 week (including a week end), and had to hang freely in the air, not to be placed within 1 m of an area where someone regularly smokes, or in a place where air does not circulate (e.g. a corner, under a shelf, or buried in curtains). Personal samplers were used in discos and pubs on Saturday nights, and had to be clipped to a shirt collar or lapel, with the windscreen facing out, away from the clothes, for a minimum period of 4 h. Results from personal and environmental samplers are comparable (Jenkins and Counts, 1999; Sterling et al., 1996). Four samples were not available, because the windscreens of the samplers were broken during sampling time. For each town, we collected about 10% of blank filters. The filters were analyzed at the Laboratory of the Public Health Agency of Barcelona, by gas chromatography/mass spectrometry (GC/MS) method. The lower limit of detection is 0.01 μg/ml. The nicotine concentration ($\mu g/m^3$) was obtained by dividing the observed nicotine level by the flow rate (24 ml/min for passive sampling) and allowing for the time the filter had been exposed. For environmental monitors, the sampling time used in the calculation of nicotine concentration, is the total time of placement of the samplers in HPs. The nicotine concentrations from environmental monitors were calculated to reflect the average exposure during working time (Hammond, 1993; Hammond et al., 1995).

Statistical analysis

Medians, means, and interquartile ranges (IQRs) were used to describe the data. We compared differences among distributions of pre- and post-ban measurements using the Wilcoxon rank sum test.

Lifetime excess lung cancer mortality risk estimates were derived from ambient nicotine concentrations using the Repace and Lowrey's risk model, which estimates that lung cancer mortality risk of 10^{-6} occurs at an 8-h time-weighted average exposure concentration of 7.5 ng of nicotine per cubic meter of workplace air for a working lifetime of 40 years (Repace and Lowrey, 1993).

Results

We analyzed 262 samples placed in 74 settings, 19 in Austria and 55 in five Italian towns (Tables 1 and 2).

In bars, restaurants, and discos/pubs in Florence and Belluno, nicotine concentrations significantly decreased, in median, from 19.02 to 0.25 $\mu g/m^3$; from 2.03 to 0.10 $\mu g/m^3$; from 35.16 to 0.01 $\mu g/m^3$, respectively (Table 1). Overall, in Florence and Belluno, median decreased significantly ($P < 0.001$) from 8.86 (mean: 45.25; IQR: 2.41–45.07) to 0.01 $\mu g/m^3$ (mean: 1.32; IQR: 0.01–0.41). On the contrary, in Vienna (no anti-smoking law), the medians of nicotine concentrations collected in winter 2004 and winter 2007 were, respectively, 11.00 (mean: 23.58; IQR: 2.53–30.38) and 15.76 $\mu g/m^3$ (mean: 17.73; IQR: 2.22–31.93), with no significance differences in terms of rank distribution (Table 1). Post-ban measurements collected in Naples, Turin, and Milan in winter 2007 (Table 2; mean: 2.79; median: 0.01 $\mu g/m^3$; IQR: 0.01–0.16), confirmed post-ban measurements in Florence and Belluno. No significant differences in nicotine concentration in hospitality premises after the smoking ban were observed amongst the five Italian towns.

The medians of nicotine concentrations of the overall samples collected before the Italian smoking ban (in Italy: 8.86 $\mu g/m^3$; in Austria: 11.00 $\mu g/m^3$) translates, using the formula of Repace and Lowery, into a lifetime excess lung cancer mortality rates for hospitality workers (bar, disco–pub and restaurant workers) of 11.81 and 14.67 per 10,000, respectively. Lifetime excess lung cancer mortality rates for bar and disco–pub workers were 10 to 20 times higher than that calculated for restaurant workers, both in Italy and Austria. For example, in winter 2002–2004 in Italy, it was 25.36, 46.88, and 2.71 per 10,000 for bar, disco–pub, and restaurant workers, respectively. After the Italian smoking ban, in winter 2007 (median nicotine concentration in Italy: 0.01 $\mu g/m^3$; in Austria: 15.76 $\mu g/m^3$), the excess lung cancer risk dropped to 0.01 per 10,000 in Italy, whereas in Austria it was 21.01 per 10,000, at the same level recorded in winter 2004.

Discussion

Main findings

This study showed a drop of more than 95% in SHS exposure in a sample of 28 Italian hospitality premises located in two towns (Florence, Belluno) after 2 years from the introduction of the Italian smoking ban. These findings were confirmed by post-ban measurements collected in other 27 hospitality premises from three different Italian towns (Naples, Milan, Turin). On the contrary, in Vienna, Austria, where no anti-smoking law entered into force up to now, SHS exposure levels in 19 HPs recorded in winter 2004 were non-significantly different from those recorded in the same HPs in winter 2007. Thus, most part of the reduction in nicotine concentration in Italian HPs can be attributed to the new law.

After 2 years, the law had a good compliance in restaurants, bars, and pubs of the five Italian towns. However, nine of 37 samples (24%) collected in Italian discos after the smoking ban were higher than 5 $\mu g/m^3$, showing that there is still room for improvement in discos.

The results in Austria indicate that the 2005 voluntary agreement between the Ministry of Health and the hospitality industry to increase the number of non-smoking zones, has failed to improve air quality, as no additional non-smoking zones were encountered in HPs in winter 2007. Anyway, in a preceding study conducted in winter 2002, no significant differences were found in Vienna restaurants between smoking (mean of nicotine concentrations: 21.3 ± 6.1 $\mu g/m^3$) and non-smoking areas (23.3 ± 15.9 $\mu g/m^3$), (Moshammer et al., 2004).

In terms of SHS exposure of hospitality workers, the lifetime excess lung cancer mortality risk dropped in Italy after the smoking ban. The Repace and Lowrey's risk model estimates that lung cancer mortality risk of 3 per 10,000 (*de manifestis* risk, i.e. a risk of obvious or evident concern) occurs at an 8-h time-weighted average exposure nicotine concentration of 2.3 $\mu g/m^3$ of workplace air for a working lifetime of 40 years (Repace and Lowrey, 1993). In Florence and Belluno measurements, 74% of samples collected before the smoking ban were higher than 2.3 $\mu g/m^3$, whereas only 17% of samples collected after the smoking ban were >2.3 $\mu g/m^3$. On the contrary, in Vienna measurements, 74 and 72% of samples collected in winter 2004 and winter 2007, respectively, were higher than 2.3 $\mu g/m^3$.

Comparison with other studies

The pre-ban levels of nicotine concentration we measured in Italy were broadly comparable with those reported by studies conducted in hospitality premises in Spain, France, Greece (Nebot et al., 2005), and Germany (Bolte et al., 2007), in Ireland before the smoking ban (Mulcahy et al., 2005), and slightly higher than those reported in Finland before the smoking restriction law (Johnsson et al., 2006).

Other studies looking at changes in airborne concentrations of SHS markers in the hospitality sector after the introduction of smoke-free law, have shown reductions in the order of 80–95% (Ellingsen et al., 2006; Mulcahy et al., 2005; Semple et al., 2007; Repace, 2004; Repace et al., 2006; Gorini et al., 2005; Ruprecht et al., 2006; Tominz et al., 2006; Travers et al., 2004; Waring and Siegel, 2006; Valente et al., 2007; Goodman et al., 2007). In Finland, where a partial smoking restriction law was introduced in July 2003, the levels of nicotine concentration reported after the introduction of the law in 20 bars, restaurants, and discos were similar to those reported before (geometric means: from 7.1 to 7.3 $\mu g/m^3$ afterwards) (Johnsson et al., 2006).

The only other before and after study in Europe between an intervention (Republic of Ireland) and a control (Northern Ireland) country, that compared SHS exposure using salivary cotinine of bar workers before and after the Irish smoking ban, found trends between the two countries similar to those observed in our study (Allwright et al., 2005).

Strengths of the study

Nicotine is considered one of the most specific and sensitive markers of SHS concentrations, and has been widely used and validated in numerous studies (Hammond et al., 1995; Navas-Acien et al., 2004; Nebot et al., 2005). The relatively large number of samples collected, the samples having been collected in the same HPs before and after the introduction of the ban, in the same season (winter), and for similar sampling times (i.e. for a week, including a week end for environmental monitor; on saturday night for discos and pubs) with a control group, guaranteed a good reliability on the results of this study. Moreover, having measured SHS exposure after 2 years from its implementation, allowed us to assess the long-term impact of the ban.

Limitations of the study

It is difficult to determine how representative our samples were of the whole Italian and Austrian hospitality premises. Our study was designed using a pre-ban set of nicotine measurements already collected at random in Florence (Middle Italy), Belluno (Northern Italy), and Vienna for previous studies (Gasparrini et al., 2006; Nebot and Lopez, 2004; Nebot et al., 2005). Anyway, to provide an overall picture of the impact of the ban, we collected adjunctive post-ban measurements from Northern (Milan, Turin) and Southern Italy (Naples). Possible selection biases could be linked to the geographical distribution, and the volume of sampled HPs, to the type of ventilation system, and the number of customers. The problem of representativeness affects similar studies, i.e. before and after study to evaluate the impact of nation-wide smoking bans or smoking restriction laws (Allwright et al., 2005; Ellingsen et al., 2006; Semple et al., 2007). Even though there had been a selection bias in our samples that may have led us to measure lower or higher SHS exposure levels recorded in winter 2004 (before the Italian ban), it seems likely that post-ban measurements collected in Italy were reasonably representative. Almost 90% of people interviewed in the survey conducted in March–April 2005 by DOXA, the Italian branch of the Gallup International Association, on a representative sample (3114 subjects) of Italian population aged 15 years or over, had the perception that the smoking ban was observed in bars and restaurants (Gallus et al., 2006). In the survey conducted in January–April 2005 amongst the owners of 1641 HPs (Italian Ministry of Health. Center for Disease Control, 2005), 92% reported that all customers respected the ban; only 11% asked to some customers to stop smoking. Figures from the authorities that enforced the law, suggested that compliance with the legislation was high, with 98.4% of premises found free from smoking activity during more than 5500 inspections conducted across Italy in January–May 2005 (Italian Ministry of Health. Center for Disease Control, 2005). Moreover, post-ban samples collected immediately after or after 1 year form the ban, in HPs located in Florence, Milan, Trieste, and Rome, showed similar patterns of reduction (Gorini et al., 2005; Ruprecht et al., 2006; Tominz et al., 2006; Valente et al., 2007).

We collected pre-ban measurements in Florence in two different periods (winter 2002 and 2004). However, SHS exposure levels were comparable in hospitality premises in these two sampling periods (Gasparrini et al., 2006; Nebot et al., 2005).

Even though Italy and Austria are not exactly comparable, in terms of population, and other characteristics, such as smoking prevalence, Italians smoking less than Austrians [25% (Gorini et al., 2007a,b; Gallus et al., 2007) vs. 29% (Shafey et al., 2003)], the introduction of the Italian ban created a natural experiment for monitoring the impact of the ban using the neighbouring Austria as the reference country, to control for secular trends unrelated to the legislative change and hence estimate how much of the change was due to the new law.

The limit of the risk model used for the assessment of excess lung cancer risk is that it is based on the assumption of a constant exposure to the nicotine concentrations we recorded, for a 40-year working lifetime (Repace and Lowrey, 1993). Moreover, we only estimated the excess lung cancer deaths for hospitality workers, but the number of heart disease deaths attributable to SHS exposure should be 10-fold higher (Repace et al., 1998; Hedley et al., 2006).

Conclusions

The 95% reduction of nicotine concentration and the drop of lifetime excess lung cancer mortality risk for hospitality workers indicate a substantial improvement in air quality in Italian HPs even after 2 years from the introduction of the ban. Looking at the results in Austria, it seems obvious to recommend the introduction of similar smoking bans in Austria and in other countries.

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Competing interests

Nothing to declare.

Ethical approval

Not required.

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