Brief Report

Air Contamination Due to Smoking in German Restaurants, Bars, and Other Venues—Before and After the Implementation of a Partial Smoking Ban

Florian Gleich, Dipl.-Vw., Ute Mons, M.A., & Martina Pötschke-Langer, M.D.

Unit Cancer Prevention and WHO Collaborating Centre for Tobacco Control, German Cancer Research Center, Heidelberg, Germany

Corresponding Author: Ute Mons, M.A., Unit Cancer Prevention and WHO Collaborating Centre for Tobacco Control, German Cancer Research Center, Im Neuenheimer Feld 280, 69120 Heidelberg, Germany. Telephone: +0-6221-42-3012; Fax: +0-6221-42-3020; E-mail: u.mons@dkfz.de

Received October 26, 2010; accepted April 18, 2011

Abstract

Introduction: The present study examined the reduction in exposure to tobacco smoke in German hospitality venues following the implementation of a partial smoking ban by measuring the indoor air concentration of $PM_{2.5}$ in 2005 and 2009, that is, before and after the legislation was implemented.

Methods: The concentration of respirable suspended particles ($PM_{2.5}$) in the indoor air of German hospitality venues was measured using a laser photometer (AM510). The prelegislation sample from 2005 included 80 venues of which 58 could be revisited in 2009. After replenishment, the postlegislation sample consisted of 79 venues.

Results: Compared with the prelegislation measurement, the concentration of $PM_{2.5}$ in hospitality venues was reduced significantly after introduction of the smoke-free legislation. The median mass concentration of $PM_{2.5}$ was reduced by 87.1% in coffee bars, by 88.7% in restaurants, by 66.3% in bars, and by 90.8% in discotheques. Notably, legal exemptions to the smoking ban are an issue: At the postlegislation measurement in 2009, the mass concentrations of $PM_{2.5}$ were substantially higher in venues allowing smoking in the whole venue or in a designated smoking room than in completely smoke-free venues.

Conclusions: The German smoke-free legislation significantly reduced the levels of respirable suspended particles in the indoor air of hospitality venues, benefiting the health of employees and patrons alike. But legal exemptions attenuated the effectiveness of the policy.

countries implemented smoking bans, which resulted in well-documented improvements of indoor air quality (Brauer & Mannetje, 1998; Connolly et al., 2009; Ellingsen et al., 2006; Goodman, Agnew, McCaffrey, Paul, & Clancy, 2007; Johnsson et al., 2006; Repace, Hyde, & Brugge, 2006; Semple, Creely, Naji, Miller, & Ayres, 2007; Travers, 2004).

But despite this large body of evidence, the German government opted against implementing a comprehensive federal smoking ban in the hospitality sector. Between August 2007 and July 2008, each of Germany's 16 federal states implemented a state law, restricting smoking in public institutions and in hospitality venues. Except for Bavaria, all federal states allowed exemptions to the smoking ban in the hospitality industry and permitted smoking in separate smoking rooms. In July 2008, after several constitutional complaints, the Federal Constitutional Court ruled that the exceptions should either be completely removed or extended to all types of hospitality venues, that is, also to small one-room venues. It gave the state legislators time until December 31, 2009, to revise their laws accordingly and as interim regulation suggested permitting smoking in one-room drinking establishments without food service, which are smaller than 75 m², and prohibit access to youths under 18 years (German Cancer Research Center, 2010; German Constitutional Court, 2008). Consequently, by the end of 2009, all federal states (including Bavaria) allowed smoking in smoking rooms and in small one-room drinking establishments.

The present study examined the reduction in exposure to SHS in German hospitality venues following the partial smoking ban by measuring the indoor air concentration of respirable suspended particles in 2005 and 2009, that is, before and after the smoke-free legislation was implemented.

Introduction

Notwithstanding its severe health implications, exposure to secondhand smoke (SHS) in public places can be easily prevented by implementing comprehensive public or workplace smoking bans including hospitality venues. In recent years, several

Methods

$PM_{2.5}$ as Indicator for SHS

Since tobacco smoke is a mixture, the level of exposure can be evaluated by using one of its components as a marker. A widely used approach is estimating SHS exposure by measuring the concentration

doi: 10.1093/ntr/ntr099

Advance Access published on May 26, 2011

© The Author 2011. Published by Oxford University Press on behalf of the Society for Research on Nicotine and Tobacco.

All rights reserved. For permissions, please e-mail: journals.permissions@oup.com

of respirable suspended particles (Brauer & Mannetje, 1998; Connolly et al., 2009; Ellingsen et al., 2006; Goodman et al., 2007; Hyland, Travers, Dresler, Higbee, & Cummings, 2008; Johnsson et al., 2006; Repace et al., 2006; Semple et al., 2007; Travers, 2004).

The validity of particulate matter with an aerodynamic diameter of up to $2.5\ \mu\text{m}$ ($\text{PM}_{2.5}$) as indicator for exposure to SHS is confirmed by studies showing a high correlation between concentrations of $\text{PM}_{2.5}$ and SHS-specific compounds (Bolte et al., 2008) or comparing $\text{PM}_{2.5}$ levels between venues with different degrees of smoking restriction (Brauer & Mannetje, 1998; Connolly et al., 2009; Repace et al., 2006; Semple et al., 2007; Travers, 2004). The mass concentration of suspended particles is measured in micrograms per cubic meter.

Study Design

This study is a follow-up to a study by our colleagues Schneider et al. (2008), which was part of a global study conducted in 32 countries (Hyland et al., 2008). The data sampling of Schneider et al. was performed in autumn 2005, when Germany had no smoke-free legislation. The follow-up study was conducted in autumn 2009 when the interim regulation suggested by the Constitutional Court was in place.

Study Sample

The prelegislation study employed a convenience sample since the information needed for probability sampling was not obtainable (Schneider et al., 2008). Nevertheless, a number of dispositions were made to ensure generalizability. The measurements were taken in 10 cities from 9 federal states clustering in the more densely settled western part of Germany; the venues were selected to cover a broad range of size, location, and type.

For the follow-up study, the sites of the prelegislation sample were revisited whenever possible. Only when the original venue was not accessible, it was substituted by the nearest comparable one in the immediate vicinity. Of the 39 restaurants, 20 coffee bars, 12 bars, and 9 discotheques visited prelegislation, 29 restaurants, 18 coffee bars, 5 bars, and 6 discotheques could be revisited postlegislation and constituted the longitudinal sample. Including the replacement venues, the postlegislation sample consisted of 39 restaurants, 20 coffee bars, 12 bars, and 8 discotheques.

All measurements were taken on Fridays and Saturdays between September 30 and October 31, 2005, and between September 25 and November 28, 2009, during the principal business hours of the respective type of venue.

Measurement Protocol

The concentration of respirable suspended particles in the indoor air of the respective sites was measured with a laser photometer (TSI SidePak Personal Aerosol Monitor AM510). The protocol for SidePak air monitoring and information about its mode of operation can be accessed at <http://www.tobaccofreeair.com/>.

Since tobacco smoke particles in the air belong almost entirely to the $\text{PM}_{2.5}$ fraction (Borgerding & Klus, 2005), the device was set to cutoff the fraction of particles with a diameter larger than $2.5\ \mu\text{m}$ (50% cutoff at $2.5\ \mu\text{m}$). Because of the specific properties of tobacco smoke, a calibration factor of 0.32 was applied to the data (Hyland et al., 2008; Klepeis, Ott, & Switzer, 2007).

The device was set to record one datapoint every minute. It was taken care to inconspicuously sample the air out of the normal breathing zone of the occupants in a central location. The investigator noted parameters such as the measuring period, size of venue, number of guests, and number of cigarettes smoked. It was further paid attention to the presence of alternative sources of particle emissions, such as candles, open kitchens, or fog machines. Whenever there was a substantial physical barrier, like a door, separating the smoke-free and the smoking room, measurements were taken in both rooms.

Data Analysis

Only data recorded inside the location was used for analysis. For venues with a separated smoking room, only the measurement taken in the nonsmoking room was used for analysis. Because of intense use of fog machines, two discotheques of the prelegislation sample and three discotheques of the postlegislation sample were excluded from all analyses.

For each venue visited, arithmetic means were computed for duration of the measurement, size of room, number of guests, number of burning cigarettes, and mass concentration of $\text{PM}_{2.5}$. The active smoker density was calculated as average number of burning cigarettes per $100\ \text{m}^3$. For the descriptive presentation, median, range, arithmetic mean, and *SD* were chosen. As the values for $\text{PM}_{2.5}$ were not normally distributed, Kendall's Tau-b was chosen as measure of association. The Mann-Whitney *U* test was used to assess the difference in $\text{PM}_{2.5}$ levels between the cross-sectional pre- and postlegislation sample and the Wilcoxon signed-rank test for the longitudinal sample.

Because of the smaller size of the longitudinal sample ($n = 56$), only some analyses were restricted to this sample. For most analyses, we treated the prelegislation and the replenished postlegislation sample as two independent cross-sectional samples. Therefore, if not explicitly stated otherwise, the data reported in the following refer to the cross-sectional samples.

All analyses were performed with PASW Statistics 18.0.

Results

Concentration of $\text{PM}_{2.5}$ and observed smoking activity were significantly positively correlated both for the pre- and postlegislation measurement (Kendall's Tau-b: 0.464 prelegislation and 0.535 postlegislation, both $p < .01$; data not shown).

The prelegislation data documented smoking activity taking place in nearly all venues (not smoke free: $n = 76$, smoke free: $n = 2$). Postlegislation, the majority of venues had banned smoking, but a substantial number allowed smoking in the whole venue or in a separate smoking room (smoking banned: $n = 55$, smoking allowed: $n = 14$, and separate smoking room: $n = 7$). However, the average $\text{PM}_{2.5}$ mass concentrations were significantly lower postlegislation compared with prelegislation for all types of venues (Mann-Whitney *U*: $p < .01$). With respect to the median, the concentration of $\text{PM}_{2.5}$ was reduced by 87.1% in coffee bars, by 88.7% in restaurants, by 66.3% in bars, and by 90.8% in discotheques (compare Table 1 and Figure 1). For discotheques, however, the reduction in average $\text{PM}_{2.5}$ levels could also be partly due to the substantially lower number of guests

Table 1. Descriptive Presentation of Prelegislation and Postlegislation Samples

Type of venue	Coffee bars (<i>n</i> = 20)		Restaurants (<i>n</i> = 39)		Bars (<i>n</i> = 12)		Discotheques (<i>n</i> = 7)	
	2005	2009	2005	2009	2005	2009	2005	2009
Duration of measurement in minutes								
Median (minimum; maximum)	61.0 (51.0; 106.0)	61.0 (29.0; 61.0)	61.0 (46.0; 156.0)	61.0 (23.0; 121.0)	61.0 (54.0; 121.0)	61.0 (60.0; 61.0)	216.0 (121.0; 241.0)	106.0 (59.0; 151.0)
Mean ($\pm$ SD)	64.4 ($\pm$ 12.2)	59.4 ($\pm$ 7.2)	64.7 ($\pm$ 16.2)	59.6 ($\pm$ 13.7)	72.0 ($\pm$ 33.4)	60.9 ($\pm$ 0.3)	209.1 ($\pm$ 40.9)	105.6 ($\pm$ 34.2)
Average number of guests present								
Median (minimum; maximum)	22.8 (3.6; 58.2)	27.1 (5.2; 100.0)	22.1 (5.2; 151.2)	21.8 (6.2; 100.0)	33.4 (1.8; 400.0)	50.0 (12.4; 100.0)	119.4 (45.8; 383.9)	60.0 (54.6; 65.6)
Mean ($\pm$ SD)	24.7 ($\pm$ 14.8)	34.6 ($\pm$ 25.9)	31.5 ($\pm$ 27.8)	29.6 ($\pm$ 23.4)	68.7 ($\pm$ 108.2)	53.4 ($\pm$ 31.2)	157.0 ($\pm$ 109.8)	60.3 ($\pm$ 3.9)
Active smoker density								
Median (minimum; maximum)	0.3 (0.1; 1.1)	0.0 (0.0; 4.2)	0.4 (0.0; 3.8)	0.0 (0.0; 3.5)	0.8 (0.0; 2.7)	0.8 (0.0; 4.2)	3.1 (0.1; 7.6)	0.0 (0.0; 0.1)
Mean ($\pm$ SD)	0.4 ($\pm$ 0.4)	0.5 ($\pm$ 1.1)	0.6 ($\pm$ 0.8)	0.1 ($\pm$ 0.6)	1.1 ($\pm$ 0.9)	1.6 ($\pm$ 1.8)	3.1 ($\pm$ 3.0)	0.0 ($\pm$ 0.0)
PM _{2.5} (μ g/m ³)								
Median (minimum; maximum)	123.5 (24.1; 1023.1)	15.9 (6.1; 337.3)	172.4 (19.8; 835.3)	19.5 (3.9; 402.7)	326.6 (24.0; 2013.2)	110.1 (5.0; 313.7)	455.7 (277.8; 1052.5)	41.8 (14.3; 313.9)
Mean ($\pm$ SD)	186.1 ($\pm$ 220.2)	53.6 ($\pm$ 89.9)	211.5 ($\pm$ 185.0)	44.6 ($\pm$ 75.6)	480.0 ($\pm$ 511.3)	116.4 ($\pm$ 98.9)	616.7 ($\pm$ 312.9)	108.1 ($\pm$ 128.7)
Smoking permission								
Smoking allowed (<i>n</i> ; %)	20; 100.0	4; 20.0	38; 97.4	3; 7.7	11; 91.7	6; 50.0	7; 100.0	1; 20.0
Smoking allowed in smoking room (<i>n</i> ; %)	0; 0.0	1; 5.0	0; 0.0	4; 10.3	0; 0.0	0; 0.0	0; 0.0	2; 40.0
Smoking not allowed (<i>n</i> ; %)	0; 0.0	15; 75.0	1; 2.6	32; 82.0	1; 8.3	6; 50.0	0; 0.0	2; 40.0

Note. Active smoker density defined as average number of burning cigarettes per 100 m³.

Figure 1. Box-and-whisker plots depicting the distribution of average PM_{2.5} levels for each type of venue measured in 2005 (prelegislation) and 2009 (postlegislation). Note: Logarithmic scaling of the y-axis. The boxplots depict the median and the interquartile range (IQR). The whiskers give the range within 1.5 times the IQR of the lower quartile and 1.5 times the IQR of the upper quartile. Any datapoints outside this range (outliers) are plotted separately.

present postlegislation, which could be associated with less people smoking in these venues.

Table 2 compares pre- and postlegislation PM_{2.5} levels in the longitudinal sample. This allows for direct comparison of the same venues at both timepoints, but due to the smaller sample size especially after further stratifications, the data may be prone to random fluctuations and should thus be interpreted with some caution. With respect to the median, the concentration of PM_{2.5} was reduced by 83.7% in coffee bars, by 87.9% in restaurants, by 86.9% in bars, and by 85.8% in discotheques. In the case of coffee bars and restaurants, the reductions proved to be significant (Wilcoxon signed-rank test: $p < .01$). Here also, the reduction in PM_{2.5} levels in discotheques could be partly due to reduced attendance postlegislation compared with prelegislation.

Postlegislation, there were significant differences in average PM_{2.5} levels between venues banning smoking and venues allowing smoking in the whole venue or in an adjoining smoking room (Figure 2). With respect to the median, the average mass concentrations of PM_{2.5} in smoke-free coffee bars were 92.4% lower than in not smoke-free coffee bars. The corresponding values for restaurants were 87.3%, for bars 84.0%, and for discotheques 81.4%. For coffee bars, restaurants, and bars, the differences proved to be significant (Mann–Whitney U : $p < .01$).

Overall, the postlegislation median concentration of PM_{2.5} in nonsmoking venues was 15.8 µg/m³ (minimum: 3.9, maximum: 97.2, $n = 55$) and 189.3 µg/m³ (minimum: 59.9, maximum: 402.7, $n = 14$) in venues where smoking was allowed in the whole location. We also noted increased levels of PM_{2.5} in the

Table 2. Descriptive Presentation of the Longitudinal Sample

Type of venue	Coffee bars (n = 18)		Restaurants (n = 29)		Bars (n = 5)		Discotheques (n = 4)	
	2005	2009	2005	2009	2005	2009	2005	2009
Duration of measurement in minutes								
Median (minimum; maximum)	61.0 (51.0; 106.0)	61.0 (29.0; 61.0)	61.0 (57.0; 156.0)	61.0 (23.0; 61.0)	61.0 (54.0; 61.0)	61.0 (61.0; 61.0)	211.0 (121.0; 223.0)	98.5 (59.0; 151.0)
Mean ($\pm SD$)	64.7 (± 12.8)	59.2 (± 7.5)	66.4 (± 18.4)	57.0 (± 10.6)	59.4 (± 3.0)	61.0 (± 0.0)	191.5 (± 47.3)	101.8 (± 38.2)
Average number of guests present								
Median (minimum; maximum)	22.8 (3.6; 58.2)	30.3 (5.2; 100.0)	23.1 (6.4; 151.2)	20.2 (6.2; 100.0)	37.6 (14.8; 79.6)	53.6 (30.0; 100.0)	109.7 (45.8; 383.9)	60.0 (54.6; 61.3)
Mean ($\pm SD$)	25.0 (± 15.4)	37.5 (± 25.6)	32.9 (± 29.8)	29.5 (± 25.6)	42.2 (± 26.8)	66.7 (± 31.7)	162.3 (± 150.8)	59.0 (± 3.0)
Active smoker density								
Median (minimum; maximum)	0.3 (0.1; 1.1)	0.0 (0.0; 4.2)	0.4 (0.0; 3.8)	0.0 (0.0; 1.4)	0.5 (0.2; 2.6)	0.0 (0.0; 3.1)	4.0 (0.2; 7.6)	0.0 (0.0; 0.1)
Mean ($\pm SD$)	0.4 (± 0.4)	0.5 (± 1.2)	0.6 (± 0.9)	0.1 (± 0.3)	0.8 (± 1.0)	0.9 (± 1.4)	4.0 (± 3.1)	0.0 (± 0.0)
PM _{2.5} ($\mu\text{g}/\text{m}^3$)								
Median (minimum; maximum)	110.4 (24.1; 1023.1)	18.0 (7.6; 337.3)	161.0 (19.8; 688.0)	19.5 (3.9; 259.0)	377.4 (146.2; 604.4)	49.4 (5.0; 241.1)	599.2 (277.8; 1052.5)	85.2 (14.3; 313.9)
Mean ($\pm SD$)	179.8 (± 230.3)	58.4 (± 93.8)	198.1 (± 163.8)	37.1 (± 53.1)	406.1 (± 198.2)	91.0 (± 94.4)	632.2 (± 383.4)	124.6 (± 142.3)
Smoking permission								
Venues allowing smoking both pre- and postlegislation (n; %)	4; 22.2		2; 6.9		2; 40.0		1; 20.0	
Venues allowing smoking prelegislation and allowing smoking in a smoking room postlegislation (n; %)	1; 5.6		4; 13.8		0; 0.0		2; 50.0	
Venues allowing smoking prelegislation and banning smoking postlegislation (n; %)	13; 72.2		23; 72.4		3; 60.0		1; 20.0	

Note. Active smoker density defined as average number of burning cigarettes per 100 m³.

Figure 2. Box-and-whisker plots depicting the distribution of average $PM_{2.5}$ levels in 2009 (postlegislation) for each type of venue and smoking status. Note: Logarithmic scaling of the y-axis. Smoke-free: no burning cigarette observed during measurement. Not smoke-free: burning cigarette(s) observed during measurement in the main room or in a smoking room. The boxplots depict the median and the interquartile range (IQR). The whiskers give the range within 1.5 times the IQR of the lower quartile and 1.5 times the IQR of the upper quartile.

nonsmoking rooms of venues with adjoining smoking rooms (median: $64.1 \mu\text{g}/\text{m}^3$, minimum: 14.3, maximum: 259, $n = 7$; Figure 3). Compared with the nonsmoking venues, the concentrations of $PM_{2.5}$ in smoking venues and in nonsmoking rooms of venues with smoking room are significantly increased (Mann-Whitney U : $p < .01$).

Discussion

This is the first evaluation of room air quality in the German hospitality sector after the implementation of partial smoking bans in 2007/2008; it demonstrates a substantial reduction of respirable SHS particles in hospitality venues. However, several exemptions attenuated the effectiveness of the policy. At the postlegislation measurement in 2009, the mass concentrations of $PM_{2.5}$ were substantially higher in venues allowing smoking in the whole venue or in a separate smoking room compared with venues in which smoking was completely banned.

The findings from this study are consistent with earlier studies of comparable design demonstrating increased indoor air pollution with respirable suspended particles when smoking is unrestricted (Brauer & Mannetje, 1998; Connolly et al., 2009; Ellingsen et al., 2006; Goodman et al., 2007; Johnsson et al., 2006; Repace et al., 2006; Semple et al., 2007; Travers, 2004). The increased levels of $PM_{2.5}$ measured in nonsmoking rooms of venues with separate smoking room are also consistent with previous studies demonstrating that in venues with designated smoking rooms, tobacco smoke penetrates into adjoining

Figure 3. Box-and-whisker plots depicting the distribution of average $PM_{2.5}$ levels in hospitality venues in 2009 (postlegislation) stratified by the venues' smoking policies. Note: Logarithmic scaling of the y-axis. The boxplots depict the median and the interquartile range (IQR). The whiskers give the range within 1.5 times the IQR of the lower quartile and 1.5 times the IQR of the upper quartile. Any datapoints outside this range (outliers) are plotted separately.

rooms (Cains, Cannata, Poulos, & Ferson, 2004; Huss et al., 2010).

The study design of the prelegislation study (Schneider et al., 2008) was accurately repeated in the postlegislation follow-up, and 72.5% of the venues of the baseline sample could be revisited. Sample attrition did not substantially affect the results. Only in the longitudinal sample of bars we observed a larger reduction in the median mass concentration of $PM_{2.5}$ than in the replenished study sample, which, however, failed to prove significant. This inconsistency is probably due to the small size of the bar sample.

As our findings suggest, the German smoke-free legislation was a mixed success. At the postlegislation measurements, all federal states allowed exemptions from the smoking ban for small drinking establishments and for smoking rooms in bars and restaurants. While a significant decline of the exposure to SHS in the hospitality sector was attained, an even greater reduction could have been possible with a comprehensive smoking ban without any exemptions. Since there is no risk-free level of exposure (U.S. Department of Health and Human Services, 2006), an effective protection of patrons and employees of hospitality venues from tobacco smoke is thus guaranteed only when smoking is completely banned.

Funding

Ute Mons is financially supported by the Klaus Tschira Foundation gGmbH. The prelegislation measurements were taken with air monitoring devices provided by Roswell Park Cancer

Institute with a grant from the Flight Attendant Medical Research Institute. The measurement protocol for SidePak air monitoring used in this study was supported by funding from the Flight Attendant Medical Research Institute and by grants to the International Tobacco Control Policy Evaluation Project from the National Cancer Institute.

Declaration of Interests

None declared.

Acknowledgments

We acknowledge the previous work of colleagues who had conducted the prelegislation measurements in 2005.

References

- Bolte, G., Heitmann, D., Kiranoglu, M., Schierl, R., Diemer, J., Koerner, W., et al. (2008). Exposure to environmental tobacco smoke in German restaurants, pubs and discotheques. *Journal of Exposure Science and Environmental Epidemiology*, 18, 262–271. doi:10.1038/sj.jes.7500590
- Borgerding, M., & Klus, H. (2005). Analysis of complex mixtures—Cigarette smoke. *Experimental and Toxicologic Pathology*, 57 (Supp. 1), 43–73. Retrieved from <http://linkinghub.elsevier.com/retrieve/pii/S0940299305000369>
- Brauer, M., & Mannetje, A. (1998). Restaurant smoking restrictions and environmental tobacco smoke exposure. *American Journal of Public Health*, 88, 1834–1836. Retrieved from <http://ajph.aphapublications.org/cgi/content/abstract/88/12/1834>
- Cains, T., Cannata, S., Poulos, R., Ferson, M. J., & Stewart, B. W. (2004). Designated “no smoking” areas provide from partial to no protection from environmental tobacco smoke. *Tobacco Control*, 13, 17–22. doi:10.1136/tc.2003.005488
- Connolly, G. N., Carpenter, C. M., Travers, M. J., Cummings, K. M., Hyland, A., Mulcahy, M., et al. (2009). How smoke-free laws improve air quality: A global study of Irish pubs. *Nicotine & Tobacco Research*, 11, 600–605. doi:10.1093/ntr/ntp038
- Ellingsen, D. G., Fladseth, G., Daae, H. L., Gjolstad, M., Kjaerheim, K., Skogstad, M., et al. (2006). Airborne exposure and biological monitoring of bar and restaurant workers before and after the introduction of a smoking ban. *Journal of Environmental Monitoring*, 8, 362–368. doi:10.1039/B600050A
- German Cancer Research Center. (2010). *The failure of partial smoking bans in hospitality venues: The example of Germany and Spain*. Heidelberg, Germany: German Cancer Research Center. Retrieved from http://www.dkfz.de/de/tabakkontrolle/download/Publikationen/AdWfP/AdWfP_Failure_of_partial_smoking_bans.pdf
- German Constitutional Court. (2008). *Urteil des Ersten Senats vom 30. Juli 2008, 1 BvR 3262/07 [Decision of the first senate from July 30th 2008, 1 BvR 3262/07]*. Karlsruhe, Germany: German Constitutional Court.
- 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
- Huss, A., Kooijman, C., Breuer, M., Bohler, P., Zund, T., Wenk, S., et al. (2010). Fine particulate matter measurements in Swiss restaurants, cafes and bars: What is the effect of spatial separation between smoking and non-smoking areas? *Indoor Air*, 20, 52–60. doi:10.1111/j.1600-0668.2009.00625.x
- Hyland, A., Travers, M. J., Dresler, C., Higbee, C., & Cummings, K. M. (2008). A 32-country comparison of tobacco smoke derived particle levels in indoor public places. *Tobacco Control*, 17, 159–165. doi:10.1136/tc.2007.020479
- Johnsson, T., Tuomi, T., Riuttala, H., Hyvarinen, M., Rothberg, M., & Reijula, K. (2006). Environmental tobacco smoke in Finnish restaurants and bars before and after smoking restrictions were introduced. *Annals Occupational Hygiene*, 50, 331–341. doi:10.1093/annhyg/mel011
- Klepeis, N. E., Ott, W. R., & Switzer, P. (2007). Real-time measurement of outdoor tobacco smoke particles. *Journal Air Waste Management Association*, 57, 522–534. doi:10.3155/1047-3289.57.5.522
- Repace, J. L., Hyde, J. N., & Brugge, D. (2006). Air pollution in Boston bars before and after a smoking ban. *BMC Public Health*, 6, 266. doi:10.1186/1471-2458-6-266
- Schneider, S., Seibold, B., Schunk, S., Jentzsch, E., Potschke-Langer, M., Dresler, C., et al. (2008). Exposure to secondhand smoke in Germany: Air contamination due to smoking in German restaurants, bars, and other venues. *Nicotine & Tobacco Research*, 10, 547–555. doi:10.1080/14622200801902029
- 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
- Travers, M. J. (2004). Indoor air quality in hospitality venues before and after implementation of a clean indoor air law—Western New York, 2003. *Morbidity Mortality Weekly Report*, 53, 1038–1041. Retrieved from <http://www.cdc.gov/mmwr/previiew/mmwrhtml/mm5344a3.htm>
- U.S. Department of Health and Human Services. (2006). *The health consequences of involuntary exposure to tobacco smoke. A report of the surgeon general*. Atlanta, GA: Public Health Service, Office of the Surgeon General.