Contribution of smokers, ambient air pollution and establishment characteristics to fine particulate matter concentrations inside bars, restaurants and cafes

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Background / Objectives

Background
About a third of the Swiss population smokes, which is still allowed in many public places such as restaurants and bars. Consequently, many employees and non-smokers are involuntarily exposed to Environmental Tobacco Smoke (ETS) in such establishments.

Objectives
- To investigate the ETS-concentrations in bars, cafes and restaurants in central Zurich during the months of August and September 2008, when no smoking ban existed
- To analyse the impact of potential sources and establishment characteristics on the ETS-concentrations.

Method / Strategy

Study design
A sample of 102 hospitality establishments was randomly selected among the 700 restaurants of central Zurich. The places were visited at random time points on all weekdays from morning until midnight during 14 days in August-September 2008. Each visit lasted 30 minutes.

Exposure measurement
ETS-exposure was determined by measuring fine particle (PM2.5) concentrations with a nephelometer positioned on top of a table that was away from open windows and particle source such as a flame grills, candles etc. If available, seating was chosen in a non-smoking area.

Other parameters
Numbers of smokers, other sources, seats, open windows, and open doors were recorded. Ambient air pollution data was obtained from public authorities.

Statistical analysis
Grouping variables were compared by Kruskal-Wallis rank sum test and Two-Sample Kolmogorov-Smirnov Test. Robust MM regression was used to investigate the influence of number of smokers and size of the establishment.

Results

Investigated establishments
Measurements were conducted in a total of 102 establishments over 14 days between August 14 and September 1, 2008 (Table 1).

Table 1: Summary statistics of the 102 visited establishments.

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Seats</td>
<td>20</td>
<td>65</td>
<td>200</td>
</tr>
<tr>
<td>Number of Guests</td>
<td>0</td>
<td>12</td>
<td>80</td>
</tr>
<tr>
<td>Number of Smokers</td>
<td>0</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Number of Staff</td>
<td>1</td>
<td>3</td>
<td>20</td>
</tr>
</tbody>
</table>

Bars showed significantly higher (mean 81.1 µg/m³) concentrations than restaurants and cafes. Bars also had more smoking guests. Concentrations were highest in the late evening.

Concentrations inside and outside
Time courses were analysed (Graph 3) and average concentrations inside and outside calculated. The average PM2.5 inside establishments was 64.7 µg/m³ (StDev 73.2 µg/m³, 30-min maximum 452.2 µg/m³). Concentrations inside the establishments were significantly higher than outdoors (p<0.001, Kolmogorov-Smirnov).

Regression model
PM2.5 inside the establishments was significantly associated with number of smokers (Graph 1), percentage of seats occupied by smokers (Graph 2), and outdoor PM. Each smoker increased PM2.5 on average by 15 µg/m³.

Discussion and Conclusion

What do the results represent
This is a representative assessment of PM2.5 in bars, cafes and restaurants of central Zurich in late summer of 2008. Due to the pleasant summer weather most guests chose to sit outside, in terraces and beer gardens rather than inside. Many doors and windows were open during the measurements. Such patterns, in tandem with positive meteorological summer conditions paint a „best case scenario“ picture whereby results are likely to reflect the lowest concentration levels of the year. The concentrations in the examined establishments were nevertheless high by reaching maximal 30-minute-average concentrations of up to 450 µg/m³. Ambient air pollution levels were in the same time period much lower with an average of 24 µg/m³ for PM10.

Health relevance
Step 1: Estimate the contribution to the overall PM2.5 exposure.
A) Employees will receive an annual average of about 20 µg/m³ if working in a bar with 100 µg/m³ tobacco smoke during 235 working days of 8 hours.
B) Guests of a one a smoky bar with 450 µg/m³ will see from a one-hour visit an increase of the average PM2.5 exposure by about 20 µg/m³.

Step 2: Comparison with epidemiological data on ambient PM2.5-mortality.
Rough estimation of risk:
> Risk of bar employees for long-term all-cause, cardiopulmonary, and lung cancer mortality is increased by 8%, 12%, and 16%.
> Daily mortality risk of a guest in a smoky bar increases by 3% on the day of the visit.

Conclusions
This study demonstrates that already few smokers strongly affect air quality by bringing particle to levels that imply serious health consequences for both employees and clients.

Acknowledgements
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