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Air quality in bars, cafes and restaurants in central Zurich in summer 2008

Final Report

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1 Introduction:

The following study requisitioned and funded by the association Lung League Zurich took place during the months of August and September 2008. Its aim was to ascertain the air quality in bars, cafes, and restaurants of Zurich and determine the individual and overall average particle mass concentration levels in these. It is worth noting that smoking is still permitted within such establishments in the canton of Zurich, unlike in many other European countries which have enforced smoking bans in workplaces and public places such as Ireland, Norway and The Netherlands. In recent years the Swiss Federal government has begun taking steps to curb smoking in public places. In 2005 the Public Transport Union (PTU) enforced a ban on smoking in all Swiss (public) trains, buses and boat services, as well as within any public transport buildings, reasoning that "protecting passengers against passive smoking was more important than individual freedoms."

Nevertheless, at the current time of writing, only 6 of 26 Swiss cantons have implemented laws to curb smoking in public places, with only two of those, Ticino and Geneva, having enforced a full ban. The economic burden of smokers is well documented: according to government figures for 2007, around a third of Swiss smoke. They cost the economy an estimated CHF 10 billion a year in medical bills, absenteeism, invalidity and premature deaths.

An extra half a billion is added to that for secondary smokers. (Vitale, Priez & Jeanrenaud, 1998). Smoking is estimated to kill over 8,000 people in Switzerland a year, a fifth of them non-smokers. According to the Federal Offic of Public Health (FOPH), most secondary smoking takes place in restaurants and bars. Results of a survey published by the FOPH indicate that three out of four non-smokers are in favour of a total ban on smoking in public places, whilst apparently 40 percent of smokers also support the motion. These results have been fervently challenged by the hotel and restaurant federation, GastroSuisse, which represents some 20,000 establishments throughout Switzerland and says its own recent survey of 500 people showed that 77 percent of respondents were in favour of a smoking area in restaurants.

Regardless of personal opinion and position, the scientific evidence concerning the adverse effects of smoking and second-hand ´passive´ smoking is overwhelming. It follows logically then that bans on smoking in bars, restaurants, cafes and similar public establishments would serve to substantially increase air quality levels comparative to pre-ban levels. Indeed, this is precisely what is reported by Travers et al. (2003) who conducted a study following New York's statewide law to eliminate smoking in enclosed workplaces and public places. What they found was significantly reduced RSP (respirable suspended particles) levels in western New York hospitality venues. Moreover, RSP levels were reduced in every venue that permitted smoking before the law was implemented, including venues in which only second-hand smoke from an adjacent room was observed at baseline. The results of Travers et al.´s study add to those found in similar studies by Goodman et al. (2007) and Eisner et al. (1998) which also report substantial improvements in indoor air quality following smoking bans.

The pertinence of the current study is thus outlined: At present employees and non-smokers in public establishments in Zurich are likely to be exposed to second-hand smoke and particle concentration levels higher then the recommended limit set by the World Health Organization (WHO), which as documented is likely to have both short term and long term adverse effects to their health. The goal of this study was to establish the concentration levels of public establishments in Zurich, namely bars, cafes and restaurants, where the FOPH believes most smoking to take place. The purpose of this study was twofold: primarily it was aimed to allow an analysis of particle concentration levels leading to the calculation of an overall average for a 14 day measurement period in August-September 2008, and secondly it was to analyse whether non-smokers and staff of such establishments are being exposed to elevated particle concentration levels.

Furthermore, the relevance of the study is even more applicable to the current political climate given that the canton of Zurich is due to have a referendum in October 2008 to judge on the future of the right to smoke in public places. Should a smoking ban come into place as in Ticino and Geneva, this study would be highly useful for comparative purposes with the results of a repeat study performed after a potential ban.

2 Method

2.1 Study Design

The initial plan was for a 3 week measurement period of 5 days each with blocks starting on different weekdays. This was later changed to have simply 14 measurement days over a 3 week period so that every day of the week would be measured twice. In order to cover most of the day´s working hours, each weekday would be covered in two blocks, one ranging from late morning to early evening (approximately 11.00 am-18.00 pm) and the other ranging from early evening to closing time (approximately 18.00 pm – 01.00 am).

2.2 Selection of Establishments

For practicality purposes, the zone of study focussed upon Zurich's city centre. This is also where it was presumed most bars, restaurants and cafes would be found. The zone of study was defined by Swiss postcode; the following were considered to be part of central Zurich and were included: 8001, 8002, 8004, 8005, 8006, and 8008. Due to zone 8002 being particularly long, it was halved and only the northernmost half was included as the southern section stretched too far from the central part of Zurich. The cut-off point was defined where one quarter led into another, so Enge being the northernmost district was included but Wollishofen was not. In order to avoid bias in terms of establishment selection, a search was made using the public directory internet service “The Yellow Pages” (http://www.directories.ch). The search title was refined to “bar, cafe, restaurant” and the postcodes included were as stated above. This search resulted in a list of 722 establishments. From these, a list of 230 establishments was compiled using a random number generator (Microsoft Excel 2000), and from this 230, a list of 12 establishments was made for each of the 15 measurement days. Envisaging that not all establishments would be open at any given time, a reserve list of 50 establishments was created from the remaining random selection.

2.3 Apparatus

Real-time PM2.5 concentrations (particulate matter smaller than 2.5 micrometers) were measured as 10-second averages with a nephelometer (pDR-1000, Thermo Fisher Scientific, Waltham, MA, U.S.A.). This device measures particle concentrations with the principle of light scattering. It provides measurements of ambient PM2.5-concentrations. The values obtained with this device correspond very well to values obtained with gravimetric methods (Riediker et al, 2003). The nephelometer was zeroed daily before going to the field. The apparatus was manufacturer calibrated to an aerosol of Arizona desert dust. In previous studies, the sampler was found to be influenced by high levels of relative humidity (Howard-Reed et al., 2000). Therefore relative humidity was measured using a humidity detector (HOBO U12, Onset Computer Corp., Bourne, MA, U.S.A.).Values of PM2.5 obtained during episodes of relative humidity above 85% were evaluated for potential exclusion. It was first planned to run in parallel gravimetric samplers using size-selective PM2.5-impactor heads to compare the daily averages obtained with the pDR with the gravimetric results. However, due to technical problems with the filter heads (impactor oil contaminating the filters), these values were not available for further analysis.

2.4 Field Measurements

Every measurement day required some preparation in advance. Each establishment was located and marked using google maps. Telephone numbers were acquired so as to be able to call in advance to check if the establishment was open. The pDR was each day zeroed in a bag flushed with HEPA-filtered air before starting the field measurements. During the measurement campaign, all times were recorded when entering and exiting establishments.

Upon entering an establishment, seating was chosen in an area as central as possible, away from any open windows, source of draft or any other source which might give off particles such as a flame grill or barbecue. In establishments where there was both a smoking and non-smoking section, seating was chosen in the *non-smoking* area. The backpack to which was attached the filter heads and pDR was placed upon the table at which the experimenter was seated so that the pDR was at a level corresponding to head height when seated. Observations pertaining to the number of seats, guests, smokers, open windows and doors (and the number and size of these) as well as the presence of any source of alternative particles or any event which occurred during the 30 minute measurement period which might affect readings were annotated. In order to look as inconspicuous as possible, a non-alcoholic drink was ordered upon entering each establishment and observations were quietly annotated whilst consuming this drink. If an establishment was closed or not possible to measure for any other reason the experimenter continued to the next establishment on the list, trying at all times where feasibly possible to follow the order of establishments created by the random number generator, in this way avoiding location or time bias.

Upon returning from the field, the pDR was turned off and the time recorded in the procedural logbook. Data stored in the internal memory of pDR and HOBO devices were uploaded to a PC laptop using corresponding software and subsequently backed up.

2.5 City background concentrations

Hourly average PM10 concentrations were obtained from the National Air Pollution Monitoring Network .site "NABEL Kasernenhof". This site represents the background-concentrations in central Zurich. Exposure data was then matched to the time periods inside the establishments by defining the city background during that time being equal to the time the establishment was entered. During the measurement period of 14 days, one NABEL-value was missing. This value was replaced by the average of the two NABEL-values before and after the missing time point.

2.6 Data Analysis:

HOBO, pDR and meteorological data gathered from measurement days was amassed and collated into an excel template file for further analysis. This file also contained the entry and exit times for each establishment. The file allowed for a graphed view of pDR and HOBO readings, and allowed calculations to be made regarding the average pDR concentration (mg/m^3) per measurement day and per establishment, as well as the quartile pDR concentration level per measurement day/ establishment.

Data was analysed using SPlus 6.1 for Windows. Most of the data was not normally distributed and several outliers were present. Consequently, robust statistics were applied to calculate all the statistics. Groups were compared using the Kruskal-Wallis rank sum test and the Two-Sample Kolmogorov-Smirnov Test. Robust MM regression was used to evaluate the influence of number of smokers and size of the establishment on the PM2.5-concentrations (averages and quartiles).

3 Results:

3.1 Establishments

In total, 102 establishments were measured over 14 measurement days between August 14 and September 1, 2008. 69 establishments were immeasurable either because they were closed, food consumption was a compulsory condition to entry, the experimenters clothes did not meet the dress code required for entry, or were judged to be unsuitable due to the establishment not having the characteristics of bar, cafe or restaurant. 33 of 102 establishments, or 32%, were observed to display evidence of alternative particle sources, such as open kitchens, candles, pizza ovens and the like. 40 of 102 establishments, or 39% had one or more window open allowing draft, whilst 83% of establishments or 85 out of 102 had one or more open doorway. Table 1 shows the key descriptors of the visited establishments.

Table 1: Summary statistics of key descriptors for the guest room (indoor) of the 102 visited establishments.

	Minimum	Average	Maximum
Time Spent in an Establishment	22	33	64
Number of Seats	20	65	200
Number of Guests[1]	0	12	80
Number of Smokers	0	3	15
Number of Staff	1	3	20

The measurement period was characterized by mostly warm and sunny weather. In many occasions, almost all of the guests were sitting outdoors. The above summary statistics therefore reflect only a proportion of the guests.

3.2 Measurements

Relative humidity remained most of the time well below 70%. On 5 days, relative humidity exceeded for short durations 85%, which required further evaluation of the pDR-measurements.

[1] Number of guests without the experimenter.

Most of the high humidity occurred while outside an establishment. Inside two establishments, relative humidity was shortly exceeding 85%, but in both cases, pDR-values were unaffected. Therefore, all pDR-data was available for analysis. On one occasion the pDR had to be restarted due to a low battery problem. This resulted in a data loss of a few minutes. Summary data for that establishment corresponds to approximately 90% of total duration inside the place. It was therefore considered as valid to describe the concentration at that establishment.

The collected data was attributed to indoor and outdoor following the logbook entries. Control charts (example shown in Table 1) were generated to check for potential shifts in time.

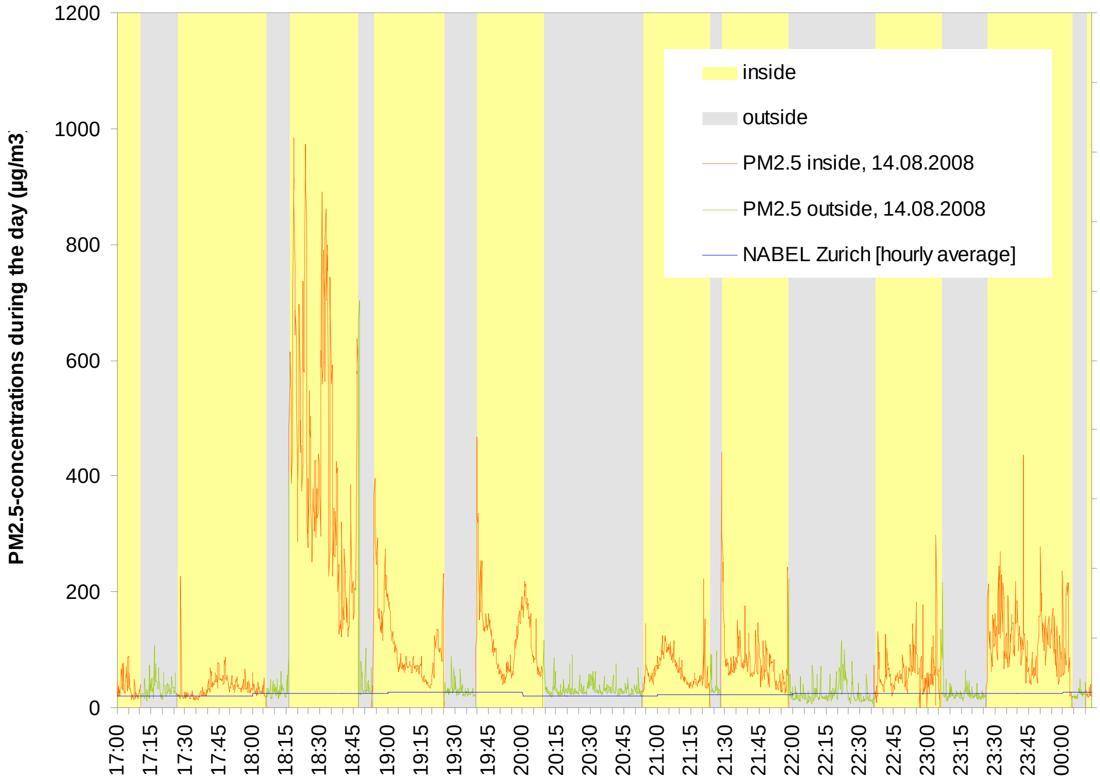

Figure 1: Graph showing the PM2.5-concentration time-course during one of the measurement days. Colors indicated measurments conducted inside establishments and outside (mostly outdoors).

Table 2 shows the basic statistics of the measurements at the urban background site (NABEL station Kasernenhof, PM10-values and temperature), and the concentrations measured while inside the establishments. The values represent average concentrations and 1st and 3rd quartile of the ten-second measurement intervals (as a robust estimator of the short-term variation inside the establishments). The concentrations inside the establishments were significantly higher than the outdoor concentrations ($p<0.001$, Kolmogorov-Smirnov).

Table 2: Exposure parameters at the city background site (NABEL, PM10-values) and inside the establishments (PM2.5-values). The concentrations inside the establishments were significantly higher than the NABEL-PM10 data.

	NABEL PM10 (µg/m³)	NABEL Temperature (°C)	Average PM2.5 (µg/m³)	1st Quartile PM2.5 (µg/m³)	3rd Quartile PM2.5 (µg/m³)
Min:	12.2	15.0	0.4	0.0	0.0
Mean:	24.4	21.3	64.7	40.9	77.9
Std Dev.:	8.6	2.8	73.2	51.4	91.7
Median:	22.3	21.3	38.3	28.0	45.0
Max:	50.5	27.5	452.2	329.0	607.0
Valid N:	102	102	102	102	102

The data was next analysed for potential influence by open doors, windows or other sources of particles. PM2.5 inside the establishment showed a tendency towards increased values in dependence of closed doors, closed windows and other sources. However, none of these factors was significant in a simple pair-wise comparison (Two-Sample Kolmogorov-Smirnov Test). Table 3 shows the statistics. It should be noted that the range of concentrations and the standard deviations were very large and that the data is based on one single dataset.

Table 3: PM2.5 concentrations grouped by status of door, window and presence of other particle sources.

	Open Door		Open Window		Other Sources	
	No	Yes	No	Yes	No	Yes
Min:	0.4	0.4	0.4	0.4	0.4	0.4
Mean:	82.2	61.2	66.7	61.6	62.0	70.2
Std.Dev.:	97.0	67.6	70.9	77.3	77.3	64.5
Median:	61.8	37.1	38.7	37.6	35.3	51.5
Max:	363.5	452.2	363.5	452.2	452.2	243.7
Total N:	17	85	62	40	69	33

Next, the hypothesis was tested that the PM2.5 concentration inside the establishments depended on a combination of sources. Specifically outdoor particle concentrations (represented by NABEL-data), the number of smokers inside the establishment and the number of "other sources" such as candles, ovens etc. Table 4 shows the results of the models calculated for the average PM2.5-concentrations and the 1st and the 3rd quartile inside the establishments. All models were tested for bias. None of the robust M-models showed a significant bias, whereas each model would have resulted in biased estimates when using a standard least-square model. NABEL and smokers contributed significantly to the PM2.5-concentrations. In contrast, "other sources" was always highly non-significant. Therefore, further calculations were conducted without this parameter.

Table 4: Coefficients for a combined sources model assuming that the PM2.5-concentrations (average or quartiles) are a combination of sources outdoors (NABEL), indoors (smokers) and others.

Model parameters	Estimate (St.Dev.)	p-value	Variation explained
1st Quartile of PM2.5			0.3499
(Intercept)	-8.7881 (6.3206)	0.1676	
NABEL PM10	1.0169 (0.2354)	<0.001	
No. of Smokers	6.822 (0.7052)	<0.001	
Other sources	0.1448 (2.238)	0.9485	
Average PM2.5-value			0.2953
(Intercept)	-12.6338 (8.3667)	0.1343	
NABEL PM10	1.4176 (0.3207)	<0.001	
No. of Smokers	8.6749 (0.8771)	<0.001	
Other sources	-3.6759 (2.8815)	0.2051	
3rd Quartile of PM2.5			0.2796
(Intercept)	-10.5208 (10.3671)	0.3127	
NABEL PM10	1.3102 (0.3997)	0.0014	
No. of Smokers	11.6574 (1.1268)	<0.001	
Other sources	-3.7226 (3.6023)	0.304	

Finally, the hypothesis was tested that the concentration inside the establishments was a consequence of outdoor source (NABEL), smokers and the size of the establishment represented by the number of available seats. An interaction term smokers*seats was included to account for the likely link between these two variables. Table 5 lists the results, while Figure 2 shows the fit of the model for the average PM2.5 concentration. Again, all of the models' results were unbiased when applying the robust statistics.

Table 5: Coefficients for a model combining the sources outdoors (NABEL) and smokers with the size of the establishment represented by the number of seats (with an interaction term smokers:seats).

Model parameters	Estimate (St.Dev.)	p-value	Variation explained
1st Quartile of PM2.5			0.3772
(Intercept)	-11.9102 (10.8072)	0.273	
NABEL PM10	1.0319 (0.2918)	0.001	
No. of Smokers	8.9738 (3.373)	0.009	
Seats	0.0296 (0.1142)	0.796	
Smokers:Seats	-0.0234 (0.0399)	0.558	
Average PM2.5-value			0.3343
(Intercept)	-10.8835 (12.6311)	0.391	
NABEL PM10	1.3228 (0.3661)	0.001	
No. of Smokers	14.9731 (2.4758)	<0.001	
Seats	0.0025 (0.1276)	0.984	
Smoker:Seats	-0.0514 (0.0239)	0.034	
3rd Quartile of PM2.5			0.2993
(Intercept)	-15.6546 (11.5961)	0.180	
NABEL PM10	1.4986 (0.3432)	<0.001	
No. of Smokers	15.1964 (2.0024)	<0.001	
Seats	0.0273 (0.1162)	0.815	
Smokers:Seats	-0.0489 (0.0204)	0.018	

All models show a significant association between NABEL-concentrations, the number of smokers and the interaction term. The coefficient for smokers suggests that each smoker contributes to an average increase of about 15 μg/m3. The negative coefficient for the interaction term means an inverse relation with the size of the establishment and the number of smokers.

In a final step, the bimodal variables open door and open window were added to the model. This did not modify the above coefficient estimates, while none of the new parameters' estimates reach significance.

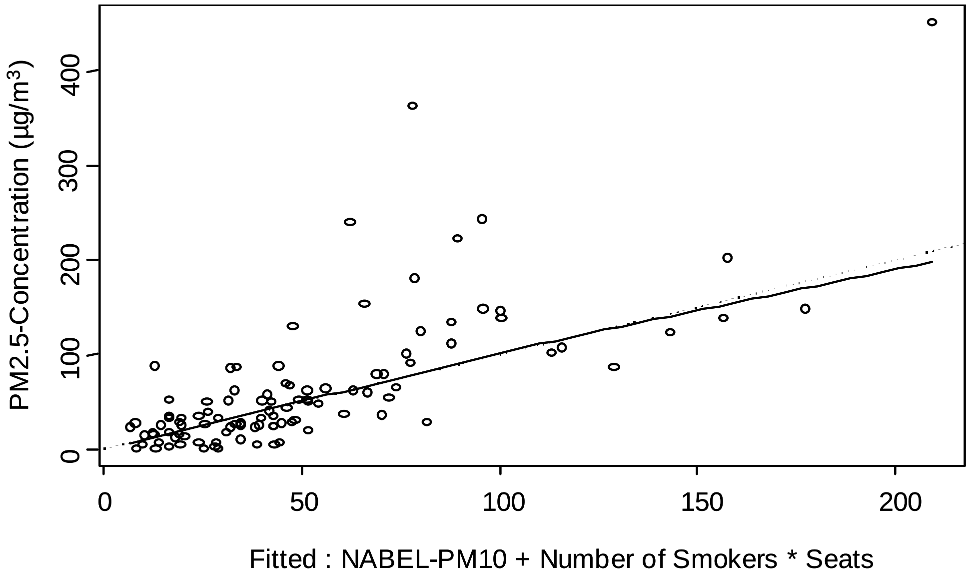

Figure 2: Quality of fit for the model "Average PM2.5-concentration ~ NABEL-PM10 + Number of smokers * Seats" (with interaction term). The model explains 33% of the variation in the data and has NABEL, smokers and interaction term as significant explaining variables.

To further examine the interaction between PM2.5-concentrations and the number or smokers the latter variable were grouped into four categories and the PM2.5-concentrations of each category subsequently displayed as a box-plot (Table 5, left side). The box plot shows a box from the 1st to the 3rd quartile, the median with a line within the box, and hinges to the farthest value that is still within a standard distance of 1.5 interquartile ranges. Extreme values are displayed with crosses. The same approach was applied to the study of the interaction term. This term basically represents the density of smokers in a given establishment. Consequently, the proportion of smokers per number of seats was calculated. Again, the numbers were categorized into four groups and are displayed as box plot, in which the influence of the interaction term is very clearly visible (Table 5, right side).

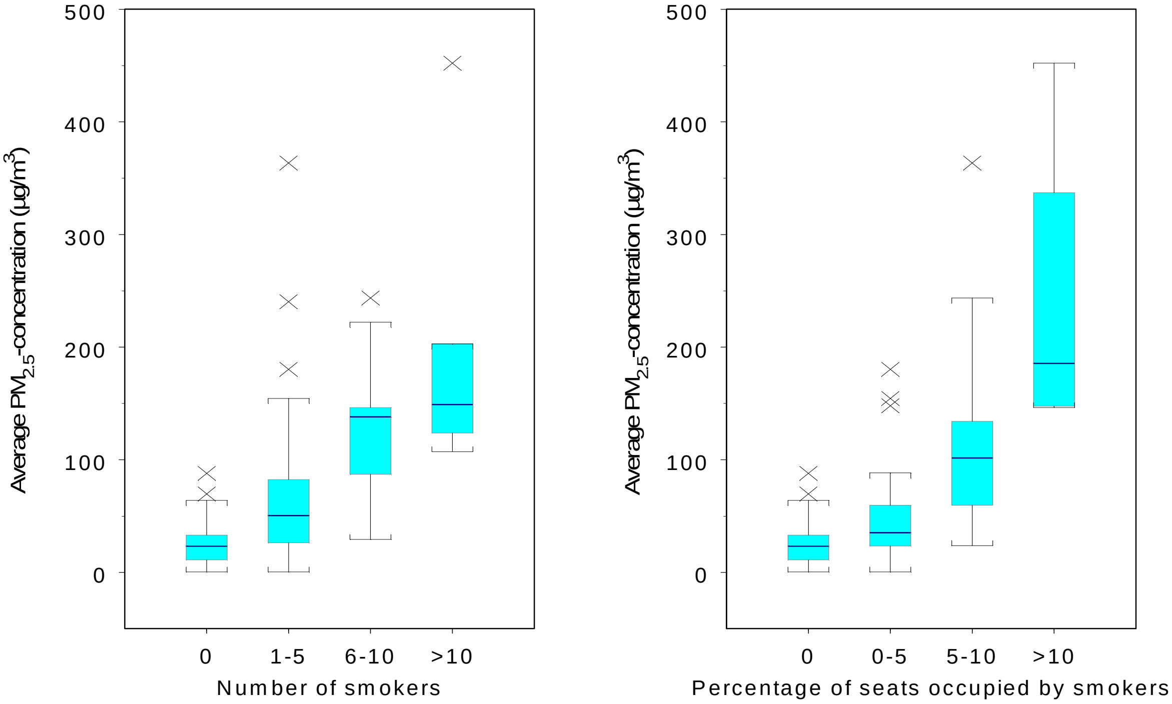

Figure 3: Box plot showing the influence of number of smokers and of the percentage of seats occupied by smokers on the PM2.5-concentrations inside an establishment.

4 Discussion:

This study examined the concentrations of fine particulate matter (PM2.5) in 102 randomly selected bars, cafés and restaurants of central Zurich in late summer of 2008. Concentrations in the examined establishments were 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.

The statistical evaluation shows a clear and strong correlation of the concentrations inside the establishments with the outdoor concentrations (represented by the NABEL-site values), the number of smokers inside the establishment and the percentage of seats occupied by smokers (in statistical wording: the interaction term smokers by seats).

The results from this study can be interpreted in several ways. Over the course of the 14 measurement days the average temperature was of 19.4 degrees Celsius. From an observational point of view most days were sunny, and heavy rain only fell on one measurement day. The effect of this pleasant summer weather was that most guests in establishments chose to sit outside, in terraces and beer gardens rather than inside. Therefore, under these parameters one would expect lower PM2.5 readings indoors to begin with.

The presented PM2.5-concentrations can be compared with two values to put them into context: first with the annual ambient PM10-limit of 20 µg/m³ and the daily limit of 50 µg/m³ (must not be exceed more than once per year). These outdoor air limits were established to protect the general population from the negative consequences of air pollution. Exposure to concentrations above these levels is generally considered as unhealthy to sensitive sub-populations. The limits apply to outdoor air only. No legal limits apply to private places such as restaurants. Inside these restaurants, the legal limits that may apply are the occupational threshold values (TLV) intended to protect the health of the employees. TLVs are defined as to protect healthy workers who spend 8 hours per working day under defined conditions. However, while it is recognized that passive smoke increases cardiopulmonary and cancer-related morbidity and mortality, there is not yet a definite TLV (comments in SUVA, 2007). It is most likely that the threshold limit value (TLV) that was established for inert dust (3 mg/m^3 of alveolar dust) is not applicable for cigarette smoke. Thus, one could turn to the epidemiological literature, which suggests that already low concentrations of fine particulate matter increases the associated risk (e.g. Brook et al. 2004).

A second effect of the encountered pleasant weather conditions was that as indicated by the descriptive statistics, 83% of establishments had one or more doorways open, whilst 39% had one or more windows open to allow a cool draft into the establishment. Therefore, under certain instances where numerous smokers were observed, PM2.5 concentration readings may not have been particularly high due to the presence of numerous open windows and doorways nearby. Conversely, it was observed that in establishments that were poorly ventilated due to the lack of open windows or doorways one smoker alone was sometimes enough to significantly influence PM2.5 concentration readings. These presumptions are in part confirmed by the trend towards higher concentrations in dependence of closed windows and doors. However, probably because of the large variability of concentrations inside the establishments, the very large influence the presence of a smoker has on the indoor-concentration, and a rather simplistic description of the ventilation effect (open vs. closed), all of the tests were not significant.

The decision to measure working day hours in two blocks was taken to account for the observation that establishments are usually fullest during weekday lunchtime hours (approx. 12pm - 2pm). Whilst it might be expected that a similar trend or pattern be observed with dinner hours this was not necessarily the case. Perhaps this is due to the fact that most people are under certain time constraints to have lunch and return to work within a certain time delay, whilst in the evening people are more flexible time wise so they can eat when they choose to, or simply choose to return home to eat after a day at work after perhaps having already eaten out once that day. Whilst this was typically a weekday observed pattern, no such pattern was obvious to the eye during weekends, although it was generally felt that there were more people in and around establishments on weekends during non lunch hours when compared to similar hours during weekdays.

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, parallel to the low number of guests per establishment, and accordingly, smokers. Results from this study could perhaps thus be used to show how only a few smokers relative to number of non-smoking guests can drastically affect air quality particle levels for both employees and other clients who under current laws in Zurich are not protected from their exposure.

A proposal for future research based upon this study would be a cross-seasonal repeat study. If the study were repeated in different seasons or months with lower average temperature and higher average rainfall one might expect to find more closed doors and windows, more guests inside, and accordingly, more smokers. A higher particle concentration would thus be expected and regarded as evidence of the damaging effect which smoking poses to indoor air quality and to the health of staff and other clients in the immediate environment.

Finally, as the canton of Zurich prepares to vote in October 2008 in a referendum concerning the right to smoke in public places this study take on more relevance to the current situation there. Should a ban on smoking in public places be enforced, a repeat study 12 months on would be extremely useful in ascertaining the hypothetical level of improvement in air quality in the bars, cafes, and restaurants of Zurich.

References

Travers, M. J., Cummings, K. M., Hyland, A., Repace, J., Babb, S., Pechacek, T., Caraballo, R.: *Indoor air quality in hospitality venues before and after implementation of a clean indoor air law - Western New York, 2003*. Morbidity and Mortality Weekly Report, 2004;53(44):1038-1041.

Goodman, P., Agnew, M., McCaffrey, M., Paul, G., Clancy, L.: *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, 2007;175:840-845.

Eisner M. D., Smith, A. K., Blanc, P. D.: *Bartenders' Respiratory Health After Establishment of Smoke-Free Bars and Taverns. JAMA.* 1998;280:1909-1914.

Vitale, S., Priez, F., Jeanrenaud, C.: *The Social Cost of Smoking in Switzerland.* Institut de Recherches Economiques et Regionales; University of Neuchatel, Switzerland, 1998.

http://www.utp.ch/L_ensemble_des_Transports_Publics_non-fumeur.html

Riediker M, Williams R, Devlin R, Griggs T, Bromberg P. *Exposure to particulate matter, volatile organic compounds, and other air pollutants inside patrol cars.* Environ Sci Technol 2003; 37(10):2084-2093.

Howard-Reed, C.; Rea, A. W.; Zufall, M. J.; Burke, J. M.; Williams, R. W.; Suggs, J. C.; Sheldon, L. S.; Walsh, D.; Kwok, R. *J. Air Waste Manage. Assoc.* 2000; *50*:1125-1132.

http://www.bafu.admin.ch/luft/luftbelastung/blick_zurueck/abfrage/index.html. Online data source for NABEL-concentrations at Kasernenhof.

SUVA 2007: *Valeurs limites d'exposition aux postes de travail 2007*. 2007; SUVA publication no. 1903.f, publisher SUVA Lucerne, Switzerland.

Brook,R.D., Franklin,B., Cascio,W., Hong,Y., Howard,G., Lipsett,M., Luepker,R., Mittleman,M., Samet,J., Smith,S.C., Jr., & Tager,I. *Air pollution and cardiovascular disease: a statement for healthcare professionals from the Expert Panel on Population and Prevention Science of the American Heart Association.* Circulation. 2004;109(21):2655-2671.