

Effects of the Irish Smoking Ban on Respiratory Health of Bar Workers and Air Quality in Dublin Pubs

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ABSTRACT

Background

Environmental tobacco smoke (ETS) causes disease in non-smokers. Workplace bans on smoking are interventions to reduce exposure to ETS to try to prevent harmful health effects. The Irish Government on the 29th March 2004 introduced the first national comprehensive legislation banning smoking in all workplaces including bars and restaurants. This study examines the impact of this legislation on air quality in pubs and on respiratory health effects in bar workers in Dublin.

Methods

Exposure study

Concentrations of PM_{2.5} and PM₁₀ particulate matter in 42 pubs were measured and compared before and after the ban. Benzene concentrations were also measured in 26 of the pubs.

Health effects study

Eighty one (81) barmen volunteered to have full pulmonary function studies, exhaled breath carbon monoxide (CO) and salivary cotinine levels performed before the ban and repeated one year later after the ban. They also completed questionnaires on exposure to environmental tobacco smoke (ETS) and respiratory symptoms on both occasions.

Findings

Pub air study

There was an 83% reduction in PM_{2.5} and an 80.2% reduction in Benzene concentration in the bars.

Barmen study

There was a 79% reduction in exhaled breath CO and an 81% reduction in salivary cotinine. There were statistically significant improvements in measured pulmonary function tests (PFTs) and significant reductions in self reported symptoms and exposure levels in volunteer non-smoking barmen after the ban.

Conclusions

A total workplace smoking ban results in a significant reduction in air pollution in pubs and an improvement in respiratory health in barmen.

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INTRODUCTION

On 29th March 2004 the Irish Government introduced the world's first comprehensive national ban on workplace smoking (1). Ten years of partial and voluntary controls on workplace exposure to secondhand smoke had failed to protect all workers (2). Two all-party parliamentary committees reporting in 1999 (3) and 2001 (4) had recommended a total ban. The Public Health (Tobacco) Act 2002 and the Public Health (Tobacco) (Amendment) Act 2004 which followed (1), prohibits smoking in indoor workplaces, including bars and restaurants in order to reduce the risks to workers' health. A number of other European countries Norway, Italy, Sweden and Scotland have subsequently introduced similar bans. Northern Ireland, England and Wales plan to introduce bans in 2007 and France in 2008. Interventions, which aim to reduce exposure to known air pollutants, can be expected to result in risk reduction (5, 6). Nevertheless there are few studies that have assessed health benefits associated with a workplace smoking ban (7-12). The benefits that accrue depend on the extent to which the intervention succeeds in reducing exposure and on the response of those exposed. The national smoking ban afforded a unique opportunity to assess the effects of the ban, both on the exposure to ETS in bars, and also to evaluate any health benefits in a group of volunteer barmen. Self reporting of changes in symptoms is interesting and important, but it was felt that it was necessary to validate these observations with quantitative measurements of changes in markers of exposure and in pulmonary function. Changes in pulmonary function, exhaled breath carbon monoxide and salivary cotinine, as markers of exposure, as well as self reported respiratory symptoms and self reported exposure level changes were measured in 81 barmen before and after the workplace-smoking ban. It was also important to know

that the banning of smoking had the expected effect on air pollution in pubs and to quantify these changes. This study measures the changes in exposure to environmental tobacco smoke (ETS) in 42 pubs. Some of the results obtained have been published in abstract form (13, 14).

METHODS

Exposure levels were measured in Dublin pubs (n=42) prior to the introduction of the smoking ban, and repeated in the same venues one year later. Volunteer bar staff (n=81) from pubs mostly different from the 42, were recruited through their trade union Mandate to partake in the health effects aspect of the study. Seventy-five volunteers (75) completed both phases of the study but 2 were excluded from the analysis because they had changed their smoking status leaving 73 for analysis of health effects. Four volunteers came from one pub and 2 volunteers came from each of 5 pubs with the remaining 59 coming from 59 different pubs. Sixty-five volunteers supported the introduction of the ban 5 opposed and 3 were undecided when entering the study.

Exposure Assessment

In the greater metropolitan area of Dublin, a group of 42 public houses, licensed to serve alcohol, were studied. The venues were selected to encompass a wide variety of building structures, clientele and were a selection of central, north and south city locations. Size, demographics and socio-economic factors were considered in the selection as well as geographic location and size. This approach was pursued to ensure that a representative sample of the different types of public houses found in Dublin city was obtained.

Based on these criteria the sample consisted of 21 pubs with capacity greater than 50 customers and 21 with capacity less than 50 customers; 14 were located in the city centre, 15 were on the north city suburbs and 13 were on the south city suburbs. Concentrations of PM_{2.5} and PM₁₀ particulate matter in 42 pubs were measured for a minimum period of 3 hours inside each venue, using a real time optical based light scattering instrument (Aerocet Met One® 531 Aerosol Particulate Profiler, Oregon) (15), with readings being taken every two minutes throughout the monitoring period. Concurrent measurements of ambient benzene levels were also recorded, using a passive absorption diffusion tube, identical to those used in the PEOPLE project (16).

The benzene samplers were available only for the last 26 pubs monitored, they were analysed by the joint research centre (JRC) laboratory of the EU at Ispra, Italy. The monitoring protocols adopted, involved the locating of the monitoring instruments at the centre of the room, at table height. The dimensions of each venue were noted, as well as the number of doors, and whether any ventilation system was in operation. In addition, the number of people present was recorded each hour, and also the number of people who were smoking. The levels of PM₁₀ and PM_{2.5} were also recorded outside the premises both before and after the indoor monitoring for both pre and post-ban parts of the study.

The 42 pubs were visited between October 2003 and March 2004 when the pre-ban exposure measurements were recorded, and re-visited one year later to measure the post-ban exposure levels. The follow-up measurements were made on the same day of the week, and at the same time of day, and in the same month, one year on from the original measurements. This controlled for the day of the week, the month (seasonal pattern) and

the time of the day effects for each venue. The outside measurements were also repeated post-ban as in the pre-ban period for comparability of prevailing ambient air pollution levels.

Health effects methodology

Eighty one (81) volunteer bar staff were recruited through their trade union Mandate to participate in the health effects study, having responded to a request by letter from us, which was circulated by Mandate to its membership. We accepted every worker who volunteered in time to allow us to complete the tests before the introduction of the ban, but would have enlarged the study if there had been more volunteers. No financial inducements were offered.

The volunteers were all male. Mandate has approximately 1100 members of whom some 80% are male. Most of the female members are temporary and or part-time workers. We do not know why there were no female volunteers, but suspect that their status as described may have influenced their decisions as the employers were vehemently against the ban and warned of job losses (17).

It was decided for reliability and quality control considerations that all subjects would be assessed in a recognized Pulmonary Function Laboratory rather than performing limited breathing tests in the workplace or at home. This allowed us to measure a wider range of Pulmonary Function Tests (PFTs) than would have been possible off site, but may have limited the numbers of volunteers. On the other hand, it allowed the barmen to participate without the involvement of their employers.

We measured the following parameters: Forced expiratory flow at one second (FEV₁.)

Forced vital capacity (FVC), Forced expiratory flow 25 - 75 (FEF₂₅₋₇₅), Peak expiratory flow (PEF), Residual volume (RV), Total lung capacity (TLC) and Diffusion capacity for carbon monoxide (DLCO) using a Sormedics Vmax machine. In addition, PEF was also measured using a Piko 1 peak flow meter. Exhaled breath Carbon Monoxide (CO) was measured using a Micro Medical Micro CO meter and carboxyhaemoglobin (COHB %) was calculated. All of the PFTs, before and after the ban were conducted by a single experienced respiratory technologist (M.A.) and were done in accordance with ERS guidelines (18, 19).

The volunteers attended St James's Hospital, between September 2003 and March 2004 for the pre-ban measurements, the follow-up measurements were conducted one year later, between September 2004 and March 2005. While at the hospital laboratory they were administered the IUATLD and CEPA (21) questionnaires relating to their respiratory and sensory symptoms, similar to that used by Eisner et al (7). Non-stimulated salivary samples for cotinine analysis were also obtained at the laboratory visits before and after the ban by a single investigator (GP) and processed as described by Allwright et al (9).

STATISTICAL ANALYSIS

The mean mass concentrations of PM_{2.5} and PM₁₀ particulate matter for each venue were analysed using the paired-sample T test procedure comparing the means of the quantitative pairs of variables using SPSS software (v 11.0).

For the purpose of analysis, the 73 volunteer bar staff were categorized as “never-smokers” (n=34), “ex-smokers” (n=31) and “current-smokers” (n=8). The pulmonary

function test results were also analyzed for each parameter by comparing the predicted score for the pre and post-ban periods using the paired-sample T test procedure. McNemar's Nonparametric Test for two related dichotomous variables for changes in responses using the chi-square distribution was used for the questionnaire data, where a volunteer reported the absence or presence of a symptom.

Markers of exposure

As the data for Carbon monoxide (CO) and Cotinine exhibited skewed distributions a nonparametric test (Wilcoxon Signed Rank) was applied to test any significant differences between the pre and post-ban CO and cotinine levels.

RESULTS

Exposure

The exposure results as measured inside the 42 bars show a statistically significant decrease following the introduction of the ban (Table 1). Complete pre and post-ban benzene measurements were available for 26 pubs and also show a statistically significant decrease following the introduction of the ban (Table 1). The ambient outdoor PM levels as measured outside each venue do not show any significant change between the pre and post-ban periods (Table 1). The reduction in PM₁₀ inside the bars was not statistically significant. These results indicate that tobacco smoke was the major contributor to both PM_{2.5} and benzene levels in pubs prior to the introduction of the workplace smoking ban. There was no smoking observed inside any of the 42 bars visited in the post-ban period confirming full compliance.

Health effects

All of the 81 volunteers completed a full set of Pulmonary Function Tests (PFTs) pre-ban, with 75 completing the post-ban measurements. Two subjects had changed their smoking status during the course of the study and were excluded from the analysis leaving 73 bar staff (90%) that completed the study and were suitable for analysis. All of the volunteers were males, working full time in pubs as their main form of employment. They had a mean age of 47.9 (22-68) years at the pre-ban assessment. Between them, they had 2298 yrs of exposure to ETS in their place of work (mean 28.4yrs) (range 6 – 52yrs). The mean self reported workplace exposure to ETS was 40.5 hrs pre-ban and 0.42 hrs post-ban showing a 99% reported decrease in exposure at work.

The total ETS exposure was 46.9 hrs pre-ban and 4.2 hrs post-ban showing a 90% decrease in total exposure. The exposure to ETS outside of work decreased from 6.4 hrs pre-ban to 3.7 hrs post-ban (% change -42%, $p < 0.01$). This is of interest as some feared that the ban could lead to increased exposure outside of work (22). FVC increased significantly in never-smokers and ex-smokers, while it declined in current-smokers. While FEV₁ did not change significantly in any group it tended to increase in non-smokers. The TLC increased in never-smokers and ex-smokers but not in smokers. Peak Flow increased significantly in never-smokers, while the increase in ex-smokers was not significant and it tended to decline in current-smokers (Table 2). The FEF₂₅₋₇₅ decreased in never-smokers and ex-smokers and was unchanged in smokers. There was no statistically significant change in RVs in any group although the RVs of smokers tended to increase (Table 2). The mean DLCO and the DLCO corrected for %COHB show a statistically significant improvement of 5% for the never-smokers group, while the reduction in ex-smokers and the smokers was not statistically significant (Table 2).

Exhaled breath carbon monoxide (CO) median values, with interquartile ranges (IQR) were ppm: 4.0 (3, 5) and 2.0 (2, 3) in pre and post-ban respectively, difference (-4.8) and is statistically significant ($p<0.001$) Fig1.

Salivary cotinine ng/ml median values, with interquartile ranges (IQR) were 5.1 (3.4, 7.6) in pre-ban and 0.6 (0.3, 1.3) in post-ban, difference (-6.1) is also statistically significant ($p<0.001$) Fig1. Median exhaled breath CO and salivary cotinine levels decreased by 79% and 81% respectively in never and ex-smokers but did not change significantly in current-smokers.

Questionnaire results

The questionnaire results obtained in this study (Table 3, Table 4) showed significant improvements in cough and phlegm production in non-smokers (never and ex-smokers combined) but not in smokers, whereas sensory irritant symptoms were improved in all subgroups but smokers benefited less.

DISCUSSION

This study shows that the workplace smoking ban in Ireland has significantly reduced the levels of both particulate matter and benzene in the air in pubs. There was a dramatic reduction in exhaled carbon monoxide levels and in salivary cotinine in barmen. The health of non-smoking bar staff has improved in terms of pulmonary function, respiratory and irritant symptoms, while in smokers only irritant symptoms have improved with other measured parameters showing a decline in the same period.

The rationale for using particles as markers of air pollution by secondhand smoke is that it is known that particles in this size range are responsible for excess mortality. We had previously shown that reduction of particle levels in ambient air resulted in marked health

benefits in terms of respiratory and cardiovascular mortality (5, 6). It has been reported (23) that ETS particles are in the size range 0.01 to 0.67 μgm^3 . The pre-ban concentrations of $\text{PM}_{2.5}$ are comparable with the findings of Levy et al (24), Lung et al (25) and to those reported by Repace (26). Repace however reported values for $\text{PM}_{3.5}$ and the exposures relate to 8 venues, all sampled during the same evening where the sampling period used was significantly shorter than that used in Dublin. These results confirm that the approach of a total ban on smoking in the workplace is successful in reducing the exposure of workers to particles. Previous studies (27, 28) have shown that partial bans do not work in this regard.

The volatile hydrocarbon benzene was used as a marker for carcinogenic substances as cigarette smoke is a well known source and we had already established ambient outdoor levels for benzene in Dublin. The post-ban levels were similar to ambient air levels suggesting that the external contribution to indoor pub air benzene was not the source of the high levels seen pre-ban. The reduction in benzene levels after the ban is similar to the drop in Poly Aromatic Hydrocarbons (PAH) reported by Repace (26).

The duration of monitoring was considered important as the particle levels vary with the number of customers smoking at any time and with the variation in air movement (Fig. 2) and short sampling times may therefore be unreliable as an indicator of overall exposure. Repace (26) reports on the change in particulate levels in hospitality venues in Delaware before and after a smoking ban, where he observed a 90% drop in $\text{PM}_{3.5}$ levels, which he attributed to ETS. The findings in this study for $\text{PM}_{2.5}$ are similar and consistent with those reported from Delaware. They are also consistent with the results presented by Mulcahy et al (29) who reported a drop in $\text{PM}_{2.5}$ values for the pre and post-ban

exposures as measured at 9 public houses in Galway, Ireland, measuring for 4 minutes in each venue. Mulcahy et al (30) also reported on cotinine and nicotine levels before and after the Irish workplace smoking ban. Currently, there is no agreed gold standard for the most appropriate markers or protocols for measurement of ETS (31) exposure but these recent studies show encouraging agreement.

This study has also served to show that a workplace ban on smoking can have immediate beneficial effects on respiratory health. The acute improvements in self reported respiratory and irritative upper airway symptoms are supported by the measurements of pulmonary function. A significant improvement in forced vital capacity (FVC) and in gas diffusion (DLCO) suggests a real health gain. The somewhat counterintuitive findings of an apparent decline in small airway function as reflected in the subdivisions of flow volume loops may have to do with altered mechanics in small airways as suggested by the increase in FVC and TLC in non-smokers and ex-smokers (Table 2) resulting in changed volume history. A similar finding seems to have occurred in the California study (7). It may also represent the reopening of small airways previously closed contributing air at a lower flow rate. The results including an increase in DLCO seem however more in favor of an improvement in a mild restrictive effect of ETS than any change in an obstructive component.

The dramatic drop in exhaled breath CO may be of significance in terms of the short term reduction in acute myocardial infarction seen in other studies but we do not have information of that in our study (8, 11). The longer-term health benefits such as in COPD, asthma, and cardiovascular disease need more prolonged studies but can be expected to occur given the known harmful effects of secondhand smoke (32). The reduction of

benzene may be an indication of a reduction in the many other known carcinogens in secondhand smoke and may contribute to a reduction in lung cancer.

The cultural and social effects of this workplace ban on smoking are likely to be profound. Earlier incomplete bans such as the Finnish ban (33) have shown significant changes; however, the Irish ban implemented to protect workers including all service workers recognizes the need for a change of mindset as regards all indoor spaces. Early results already show a significant change in attitude in smokers with a majority of smokers now favoring the ban (34). Smoking prevalence estimates show a decline in smoking of 1.4% (35) which is more than three times the average OECD expected rate of decline in the same timeframe (36).

Results from data routinely collected by the Central Statistics Office show that employment in the hospitality sector has increased again following an initial drop and that tourism has also increased despite the predictions before the ban (37). Although smoking outside pubs is a new noticeable occurrence after the ban, limited data suggests that smoking outside pubs by customers visiting pubs is only a fraction of the numbers who smoked inside pubs prior to the ban (38).

The health effects results of this study are weakened by the fact that the bar workers were all volunteers and may not be fully representative of the exposed population. They were also all male. The sample size represents only some 10% of the male membership of the Mandate Dublin Trade Union. The confidence in the magnitude of the health effects benefit is diminished by the uncertainty as regards representativeness that a volunteer group poses. In addition it was not possible to match the bar staff to the various pubs used as part of the exposure assessment as the pubs were selected as a representative sample of

Dublin pubs to show how the levels of exposure changed over a whole series of venues and the overlap with the volunteers was uncontrolled and only partial. The close correlation of the self reported improvements in symptoms and reduction in exposure with the measured improvements in pulmonary function and markers of exposure is reassuring and extends our experience of the beneficial effects of workplace bans.

We conclude that a properly implemented comprehensive workplace ban on smoking as introduced in Ireland can achieve its primary aim. It can protect workers and others from exposure to the harmful particles, chemicals and gases in secondhand smoke and result in immediate and significant health gain.

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Figure 1: Whisker plot diagrams showing the medians and interquartile ranges (IQR) of exhaled breath CO levels (ppm) and salivary cotinine levels (ng/ml) before and after the workplace smoking ban (n=73).

Figure 2: Example showing variation of PM_{2.5} levels in a Dublin pub during an evening before and after the introduction of the workplace smoking ban.

Table 1: PM_{2.5}, PM₁₀ & benzene levels in public houses and the outdoor environment before and after the introduction of the workplace smoking ban ($\mu\text{g}/\text{m}^3$).

	Pre-ban (sd)	Post-ban (sd)	% Change	P-value
<u>Public Houses (n=42)</u>				
Ave PM _{2.5}	35.5 (17.8)	5.8 (2.2)	-83.6	<0.01
Ave PM ₁₀	72.1 (27.8)	45.5 (17.1)	-36.9	NS
Benzene (n=26)	18.8 (14.0)	3.7 (1.6)	-80.2	<0.01
<u>Outdoor (n= 42)</u>				
Ave PM _{2.5}	6.0 (0.8)	5.2 (0.1)	-13.6	NS
Ave PM ₁₀	24.1 (19.3)	20.0 (5.0)	-17.4	NS
Benzene*		3.7		

Definition of abbreviations: Ave PM_{2.5} = average amount of particulate matter that is 2.5 micrometers or smaller in size; Ave PM₁₀ = average amount of particulate matter that is 10 micrometers or smaller in size; NS = not significant; and sd = standard deviation.

* Outdoor benzene mean value from PEOPLE project 28th April 04

Table 2: Respiratory function parameters and the change by smoking status before and after introduction of the workplace smoking ban.

Parameters (Units)	Total (n=73)			Never-Smokers (n=34)			Ex-Smokers (n=31)			Current-Smokers (n=8)		
	Pre	Post	P-value	Pre	Post	P-value	Pre	Post	P-value	Pre	Post	P-value
FEV₁ (l/sec)	3.42	3.41	—	3.44	3.49	—	3.38	3.35	—	3.51	3.32	—
% PRED	92.0	93.0	NS	92.0	94.0	NS	93.0	93.0	NS	88.0	84.0	NS
FVC (l)	4.21	4.32	—	4.17	4.36	—	4.18	4.29	—	4.45	4.31	—
% PRED	92.0	95.0	<0.01	91.0	96.0	<0.01	93.0	96.0	0.01	91.0	88.0	NS
FEV₁/FVC %	81.0	78.0	<0.01	82.0	80.0	<0.01	81.0	78.0	<0.05	79.0	76.0	0.03
PEF (l/min)	500.7	508.8	—	506.6	530.0	—	505.7	515.0	—	489.1	481.3	—
% PRED	94.0	97.0	<0.01	94.0	99.5	<0.01	96.0	98.0	NS	86.4	85.0	NS
FEF₂₅₋₇₅ (l/sec)	3.50	3.24	—	3.68	3.41	—	3.42	3.11	—	3.41	3.20	—
% PRED	87.0	80.0	<0.01	89.0	83.0	0.04	87.0	79.0	<0.01	78.0	73.0	NS
RV (l)	2.14	2.17	—	1.98	1.97	—	2.20	2.24	—	2.54	2.70	—
% PRED	99.0	100.0	NS	94.0	93.0	NS	101.0	101.0	NS	115	123	NS
TLC (l)	6.42	6.55	—	6.24	6.38	—	6.46	6.58	—	7.03	7.10	—
% PRED	91.0	93.0	<0.01	90.0	92.0	0.02	92.0	94.0	0.04	95.0	96.0	NS
DLCO (ml/min/mm Hg)	28.7	28.5	—	27.9	29.5	—	28.9	28.7	—	29.2	27.2	—
corr DLCO	29.1	28.7	—	28.1	29.6	—	29.2	28.8	—	30	27.8	—

corr DLCO %

PRED 93.0 94.0 NS 90.0 96.0 <0.01 95.0 95.0 NS 88.0 83.0 NS

Definition of abbreviations: FEV₁ = forced expiratory volume in one second; FVC = forced vital capacity; PEF = peak expiratory flow; FEF₂₅₋₇₅ = forced expiratory flow 25% to 75%; RV = respiratory volume; TLC = total lung capacity; DLCO = diffusing lung capacity for carbon monoxide; corr DLCO = diffusing lung capacity for carbon monoxide corrected for carboxyhaemoglobin; PRED = predicted; and NS = not significant.

Table 3: Respiratory symptoms questionnaire data before and after the workplace smoking ban by smoking status.

	Number Reporting Symptom		% Change	P-value
	Pre-ban	Post-ban		
<u>Q1. Have you had whistling/wheezing in your chest?</u>				
Total non-smokers (65)	18 (28%)	15 (23%)	-17%	NS
Smokers (8)	6 (75%)	5 (63%)	-17%	NS
<u>Q2. Have you felt short of breath?</u>				
Total non-smokers (65)	18 (28%)	10 (15%)	-45%	NS
Smokers (8)	4 (50%)	3 (38%)	-25%	NS
<u>Q3. Do you usually cough first thing in the morning?</u>				
Total non-smokers (65)	21 (32%)	11 (17%)	-48%	0.04
Smokers (8)	6 (75%)	6 (75%)	0	NS
<u>Q4. Do you cough at all during the rest of the day?</u>				
Total non-smokers (65)	36 (55%)	22 (34%)	-39%	<0.01
Smokers (8)	7 (88%)	7 (88%)	0	NS
<u>Q5. Do you bring up phlegm?</u>				
Total non-smokers (65)	44 (68%)	26 (40%)	-41%	<0.01
Smokers (8)	7 (88%)	6 (75%)	-14%	NS
<u>Total reporting any respiratory symptom?</u>	63 (86%)	45 (61%)	-28%	<0.01

Definition of abbreviations: NS = not significant.

Table 4: Irritant symptoms questionnaire data before and after the workplace

smoking ban by smoking status.

	Number Reporting Symptom		% Change	P-value
	Pre-ban	Post-ban		
<u>Q1. In the past 4 weeks have your eyes been red/ irritated?</u>				
Never smokers (34)	20 (59%)	5 (15%)	-75%	<0.01
Ex-smokers (31)	21 (68%)	2 (6%)	-90%	<0.01
Smokers (8)	3 (38%)	1 (13%)	-67%	NS
<u>Q2. Have you had a runny nose, sneezing, or nose irritation?</u>				
Never smokers (34)	22 (65%)	11 (32%)	-50%	<0.01
Ex-smokers (31)	12 (39%)	9 (29%)	-25%	NS
Smokers (8)	8 (100%)	4 (50%)	-50%	0.03
<u>Q3. Have you had a sore or scratchy throat?</u>				
Never smokers (34)	16 (47%)	7 (21%)	-56%	<0.01
Ex-smokers (31)	15 (48%)	5 (16%)	-67%	<0.01
Smokers (8)	4 (50%)	2 (25%)	-50%	NS
<u>Total reporting any irritant symptom?</u>				
	64 (87%)	32 (43%)	-50%	<0.01

Definition of abbreviations: NS = not significant.

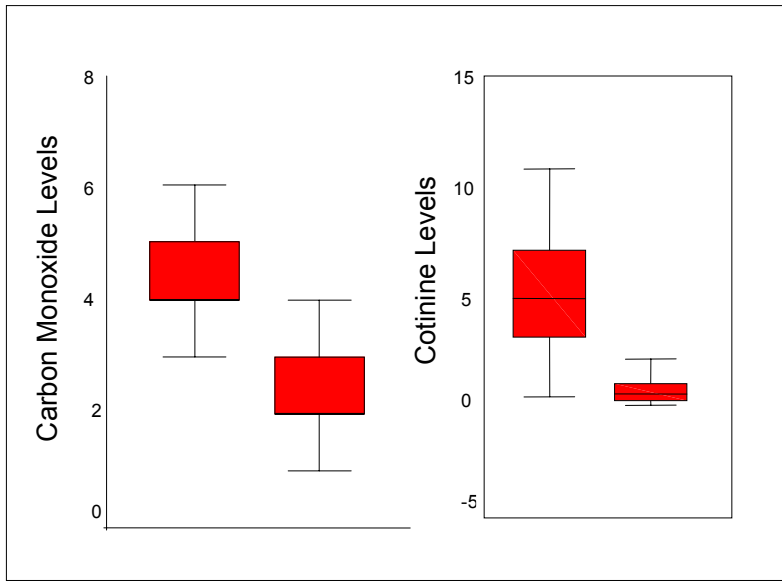


Figure 1

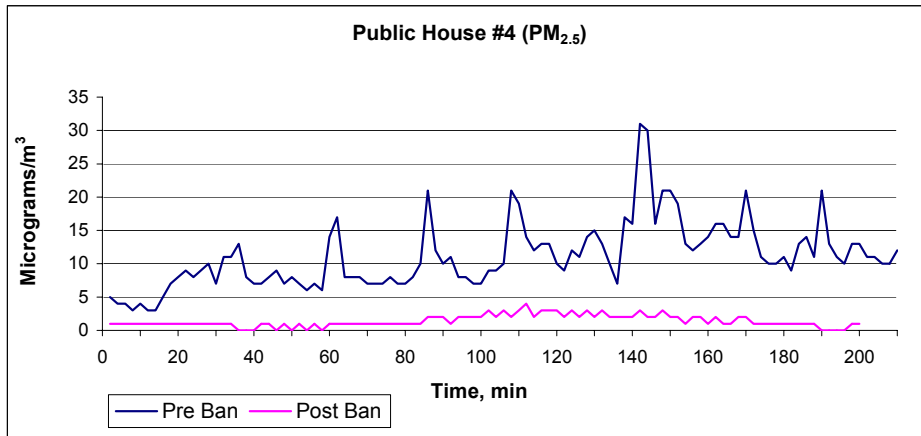


Figure 2