Second-hand smoke levels in UK pubs and bars: do the English Public Health White Paper proposals go far enough?


Abstract

Background The English Public Health White Paper proposes introducing smoke-free workplaces except in pubs and bars that do not prepare and serve food. The bar area will be non-smoking in exempted pubs.

Objective To explore the likely impact of these proposals in UK pubs and bars.

Methods A total of 59 pubs and bars within Greater Manchester in 2001 were chosen. Thirteen were mechanically ventilated, 12 were naturally ventilated and 34 had extractor fans; 23 provided non-smoking areas. We measured time-weighted average concentrations of respirable suspended particles (RSP), solanesol tobacco-specific particles and vapour-phase nicotine (VPN) over a 4-h sampling period on a Tuesday or Saturday night.

Results Second-hand smoke (SHS) levels in smoking areas were high (mean RSP 114.5 μg/m³, VPN 88.2 μg/m³, solanesol 101.7 μg/m³). There were only small (5–13 per cent) reductions in bar areas. Mean levels were lower in non-smoking areas: by 33 per cent for RSPs, 52 per cent for solanesol particles and 69 per cent for VPN. Compared with other settings (homes and other workplaces) with unrestricted smoking, mean SHS levels were high throughout all areas of the pubs regardless of ventilation strategy.

Conclusion Partial measures, like those in the English Public Health White Paper, will leave bar staff in exempted pubs unprotected from the occupational hazard of SHS.

Keywords: air quality, cross-sectional study, passive smoking, pubs and bars

Introduction

Second-hand tobacco smoke is a complex mixture of over 3800 gaseous and particulate components, including more than 50 known or suspected human carcinogens and 100 toxic chemicals. The higher levels of volatile compounds in sidestream smoke, the main component of second-hand smoke (SHS), may mean that it is relatively more toxic than directly inhaled smoke. Exposure to SHS has been associated with many diseases including lung cancer, cardiovascular and respiratory diseases. Over 10 000 deaths, including 617 in the workplace, are estimated to be caused by SHS in the United Kingdom each year.

There is clear evidence that levels of SHS are especially high in pubs and bars. Studies estimating biomarkers of exposure such as serum or salivary cotinine show that bar workers are very heavily exposed. Table 1 summarizes the results from a recent review of US studies documenting vapour-phase nicotine (VPN) levels, a commonly used SHS marker, in various settings where unrestricted smoking was allowed. SHS levels in hospitality venues, particularly bars, are well above those in other settings. Domestic and workplace exposure to SHS has been linked to adverse health effects, making it highly likely that the much higher levels of occupational SHS exposure among bar workers will affect health.

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Unlike in other European countries such as Norway, Sweden and Ireland, in the United Kingdom there is currently no specific legislation or regulations addressing SHS exposure in the workplace. However, The Scottish Executive have announced plans to make all workplaces, including pubs, bars and restaurants, smoke free from March 2006. In England, the Public Health White Paper\(^\text{10}\) proposes making all workplaces smoke free except for pubs, bars and clubs where food is not prepared and served, though smoking in the ‘bar area’ will be prohibited everywhere. Following its publication, there has been considerable public debate and debate within the public health community about the White Paper proposals.\(^\text{11}\)

At present, for the hospitality sector there is a voluntary, self-regulatory Public Places Charter (PPC).\(^\text{12}\) This focuses on providing customers with a ‘comfortable’ environment but does not explicitly address the health effects of SHS or the reduction of occupational SHS exposure.\(^\text{13}\) Pubs may be charter compliant even if they allow unrestricted smoking throughout (an option currently adopted by approximately 70 per cent of UK pubs\(^\text{14}\)), provided the policy is clearly signed and supported by a written smoking policy. Venues that allow smoking in all or part of the premise may also display a ‘ventilated premises’ sign, if there is a minimum supply of outside air (at least 8 litres/person/second). The PPC guidance on ‘charter standard’ ventilation does not set the minimum supply of outside air (at least 8 litres/person/second).

Table 1 Levels of second-hand smoke (SHS) in different settings with unrestricted smoking – adapted from a review of US studies\(^\text{9}\)

<table>
<thead>
<tr>
<th>Number of studies</th>
<th>Number of venues</th>
<th>Vapour-phase nicotine mean (µg/m(^3))</th>
<th>Vapour-phase nicotine range (µg/m(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>22</td>
<td>940</td>
<td>4.1</td>
</tr>
<tr>
<td>Residences</td>
<td>7</td>
<td>91</td>
<td>4.3</td>
</tr>
<tr>
<td>Restaurants</td>
<td>17</td>
<td>402</td>
<td>6.5</td>
</tr>
<tr>
<td>Bars</td>
<td>10</td>
<td>27</td>
<td>31.1</td>
</tr>
</tbody>
</table>

This article uses data from a study of 59 pubs in Manchester to explore the likely effectiveness of the English Public Health White Paper policy proposals at protecting staff in non–food-serving pubs and bars from exposure to SHS in the workplace.

Methods

The sampling and data collection methods have been described fully in a previous publication.\(^\text{15}\) In brief, 59 pubs and bars were studied in and around Manchester, United Kingdom, between October 2000 and July 2001. Sites were chosen at random from a single company with a diverse pub stock. All venues that were approached agreed to take part in the survey. Pub and bar types were defined by the following:

- smoking policy: either unrestricted smoking or partially restricted smoking (smoking and non-smoking areas)
- ventilation arrangements (either mechanically ventilated, extractor fan, or naturally ventilated via doors and windows).

None of the pubs were smoke free. The ‘mechanical ventilation’ category was applied to sophisticated systems and included electrostatic filters and heating, ventilation and air conditioning (HVAC) units.

Samples were taken over 4 h between 18:30 and 22:30, on either a Tuesday or a Saturday night to reflect typical weekday or weekend occupancy patterns, respectively. Several locations in each establishment were sampled, including smoking and non-smoking (where provided) public areas where consumption of food and drink occurred and the area behind the bar to assess occupational exposure levels. Formal eating areas (restaurants) were not sampled. Sample locations were chosen to be as representative as possible of the area, whilst maintaining reasonable equipment security and unobtrusiveness. The sampling equipment height was as close as possible to 1.5 m to obtain a representative mixture of air for seated and standing customers and staff.

Samples were taken using an SKC air pump (224-50, SKC, UK) calibrated to a known flow rate. Measurements included particulate-phase markers: respirable suspended particles (RSP) as PM\(_{2.5}\) (particles <2.5 \(\mu\)m aerodynamic diameter), the tobacco-specific particle solanesol (SolPM) and a gaseous-phase SHS component marker VPN.

RSP was collected on a Fluropore membrane filter (FAL 03700, 1.0 \(\mu\)m pore size, Millipore, UK) by drawing air through a 2.5-\(\mu\)m cut-off impactor sample head (200 Personal Environmental Monitor PEM, SKC, USA) and pre- and post-sampling weighing carried out with an electronic microbalance (MTS, Mettler Toledo, UK). Solanesol was extracted from the RSP-loaded filter using high-performance liquid chromatography (HPLC)-grade methanol (minimum 99.9 per cent pure, Chromsolv, Sigma Aldrich, UK) and analysed using HPLC (Hewlett Packard Series 1100 degasser G1322A, pump G1311A, and autosampler G1313A). Nicotine was collected by drawing air through a two-section XAD-4 tube at 11 per min (SKC, UK) and extracted using ethyl acetate with a triethylamine buffer. Quantification was carried out using gas-chromatography–mass spectroscopy (Trace 2000 Series, Thermoquest CE Instruments, UK). Full details of the equipment and analytical and quality control procedures can be found in a previous paper by Carrington et al.\(^\text{15}\)

Ethics approval was not required for this study.
Statistical analysis
There were 244 observations from the 59 pubs that participated in the study. Many measurements were taken in the same type of smoking area within a given pub, and therefore the data contain some data points that are not independent.

For all samples, a time-weighted average sample of each SHS marker over a 4-h sampling period was calculated. To calculate means by area and type of ventilation, we fitted hierarchical linear models with the SHS marker of interest as the outcome variable and predictor terms for ventilation type, area and the interaction of ventilation type and area. We fitted two sets of models, one for smoking and bar areas of all 59 pubs and another for the smoking and non-smoking areas in the 23 pubs that provided partial smoke-free accommodation. The predicted value from the models for each area and ventilation type was our estimate of the mean. Standard errors are reported for the predicted values of the mean. To test for differences in mean levels of the SHS markers between smoking areas and between ventilation types, we fitted similar models (without the interaction term) but used natural logs of the SHS marker data as outcome variables.

All data analyses were undertaken using Stata version 8.0 software package (Stata Corp, USA).

Results
The mean and median levels of SHS markers within the smoking and bar areas of the 59 pubs and within the smoking and non-smoking areas of the 23 pubs providing a non-smoking area are summarized in Table 2. Mean levels of VPN at the bar were only slightly less than those in the smoking areas, with reductions of 5–13 per cent (bar VPN levels 11.1 μg/m³ lower, RSP 5.7 μg/m³ lower and SolPM 8.4 μg/m³ lower). Reductions in the non-smoking areas were much greater, between 33 and 69 per cent (61.1 μg/m³ for VPN, 38.3 μg/m³ for RSP and 53.3 μg/m³ for SolPM). Figures 1 and 2 show the range of values for RSP and VPN within each pub/area by area type and type of ventilation.

A comparison with VPN levels from the review of previous US studies (Table 1) shows that SHS levels in smoking and bar areas of the Manchester pubs were 12–20 times greater than the mean found in other settings with unrestricted smoking and 2.5–3 times higher than the mean levels found in bars and pubs in other studies. Extremely high levels of VPN of over 100 μg/m³ were found in 59 of 244 (about 25 per cent) measurements, with one or more VPN levels above 100 μg/m³ in the smoking and/or bar areas of 25 out of 59 (42 per cent) of the pubs (Fig. 2). Even in the non-smoking areas of the Manchester pubs, mean VPN levels were over four times higher than the mean from other settings with unrestricted smoking and were similar to the mean levels found in bars and pubs with unrestricted smoking in US studies.

Table 3 summarizes mean SHS marker levels for smoking and bar areas in the pubs with unrestricted smoking by ventilation type. In the pubs with mechanical ventilation, mean SHS levels were raised, though not statistically significantly, in the bar areas compared with the smoking areas (VPN by 9 per cent, RSP by 29 per cent and SolPM by 64 per cent).

Table 4 summarizes mean SHS marker levels by ventilation type for smoking and non-smoking areas in the 23 pubs with partial smoking restrictions. Even in the non-smoking areas of mechanically ventilated pubs, mean VPN levels are still far higher than in other settings where unrestricted smoking is allowed (Table 1).

Discussion
Main finding of this study
We found high levels of SHS markers in smoking and non-smoking public areas and behind the bars of UK pubs, much higher than recorded in other settings where smoking is allowed. The high levels of solanesol, a tobacco-specific particulate

<table>
<thead>
<tr>
<th>SHS marker</th>
<th>Statistic</th>
<th>Smoking</th>
<th>Bar</th>
<th>Non-smoking</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSP (PM&lt;sub&gt;2.5&lt;/sub&gt;, μg/m³)</td>
<td>n</td>
<td>138</td>
<td>83</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>114.5</td>
<td>108.8</td>
<td>76.2</td>
</tr>
<tr>
<td></td>
<td>SE of mean</td>
<td>6.8</td>
<td>9.3</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>93.8</td>
<td>83.3</td>
<td>68.8</td>
</tr>
<tr>
<td></td>
<td>Interquartile range</td>
<td>50.0–152.1</td>
<td>56.3–141.7</td>
<td>41.7–108.3</td>
</tr>
<tr>
<td>SolPM (μg/m³)</td>
<td>n</td>
<td>137</td>
<td>83</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>101.7</td>
<td>93.3</td>
<td>48.4</td>
</tr>
<tr>
<td></td>
<td>SE of mean</td>
<td>9.2</td>
<td>11.9</td>
<td>9.7</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>63.8</td>
<td>53.0</td>
<td>29.7</td>
</tr>
<tr>
<td></td>
<td>Interquartile range</td>
<td>22.2–148.3</td>
<td>22.5–112.7</td>
<td>13.7–71.3</td>
</tr>
<tr>
<td>VPN (μg/m³)</td>
<td>n</td>
<td>134</td>
<td>81</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>98.2</td>
<td>77.1</td>
<td>27.1</td>
</tr>
<tr>
<td></td>
<td>SE of mean</td>
<td>7.7</td>
<td>8.5</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>63.0</td>
<td>61.8</td>
<td>21.1</td>
</tr>
<tr>
<td></td>
<td>Interquartile range</td>
<td>23.7–132.3</td>
<td>25.4–93.4</td>
<td>10.6–42.7</td>
</tr>
</tbody>
</table>

RSP, respirable suspended particles; SolPM, particle solanesol; VPN, vapour-phase nicotine.
marker, indicate that the major source of RSP in these hospitality environments was from smoking activity. Mean levels were lower in non-smoking areas: by 33 per cent for RSP, 52 per cent for solanesol particles and 69 per cent for VPN. Regardless of the type of ventilation used, mean VPN levels even in non-smoking areas were at least 4–5 times higher than those found in studies of other workplaces and homes with unrestricted smoking. SHS exposure in such settings (homes and other workplaces) have been causally associated with adverse health effects from long-term exposure.2,4,6 This strongly suggests that levels of SHS in the smoking and smoke-free areas of these hospitality venues are an important occupational health hazard.

What is already known on this topic

A safe level for SHS in indoor environments has not been defined. A minimum standard should be to reduce SHS levels where smoking is allowed to well below levels that have been demonstrated to have adverse health effects in other settings.

Previous studies have shown that levels of SHS are especially high in pubs and bars.6 Studies have shown that the effect of smoke-free areas is limited.16–18 with mean levels of SHS markers remaining high compared with SHS exposures in other settings with unrestricted smoking.

There is no evidence that mechanical ventilation can reduce SHS levels in pubs where significant smoking is occurring to anything approaching a safe level.19 Indeed, previous analysis of the Manchester data found no evidence that SHS marker levels were reduced in pubs with mechanical ventilation systems.15 However, investigation of the effectiveness of ventilation was limited by possible confounding factors between venues, e.g. in the geometry and volume of premises and the level of smoking in each pub.

What this study adds

This article presents real-world data from a large number of pubs and bars in a large English city. The effect of smoker segregation and ventilation is examined. The study is the largest reported study of this type conducted in pubs and bars, with twice the number of venues than were investigated in the combined studies reviewed by Siegel and Skeer.9 We used a wider range of SHS markers than many other studies.

The data confirm the very high levels of SHS exposure in pubs where smoking is allowed. They also show that providing smoke-free areas, whatever the ventilation type, only partially reduces SHS exposure for customers and staff within non-smoking areas and does not remove the health hazard. As reported previously,15 the finding of a greater relative reduction

Figure 1 Distribution of respirable suspended particles (RSP) (PM$_{2.5}$) in smoking sections, non-smoking sections and bar areas of all pubs categorized by ventilation type.
in VPN levels may indicate that VPN is a poor marker of SHS exposure in non-smoking areas compared with particulate markers, because of the tendency for nicotine to be adsorbed onto surfaces within the smoking sections. Reductions of particulates between the smoking and non-smoking areas were much less than for VPN (Table 4).

The very high level of SHS markers described in areas behind the bar provides clear evidence that SHS exposure in pubs and bars is an occupational hazard. At the time of this survey (2001), few of the bars had policies to restrict smoking at the bar. However, the limited reductions in mean SHS marker levels seen in the non-smoking areas in these pubs suggest that the English Public Health White Paper proposal to protect bar staff by prohibiting smoking at the bar in exempted pubs will not protect staff from the health risks due to SHS exposure. In addition, many staff in these pubs will not spend all their working time in the bar area and will be fully exposed to the highest levels of SHS when working in unrestricted smoking areas.

The tobacco industry has actively promoted ventilation as an effective solution to the problem of SHS and which will allow continued smoking in public places and workplaces.20 However, SHS levels were high even in pubs with mechanical

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**Table 3** Mean level (and standard error) of second-hand smoke (SHS) markers in smoking and bar areas in all 59 pubs – by ventilation type

<table>
<thead>
<tr>
<th>SHS marker (µg/m³) (n = 40)</th>
<th>Mechanical (n = 40)</th>
<th>Extractor (n = 141)</th>
<th>Natural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smoking area (n = 24)</td>
<td>Bar area (n = 16)</td>
<td>Smoking area (n = 88)</td>
</tr>
<tr>
<td>RSP (PM₂.₅)</td>
<td>82.5 (18.3)</td>
<td>106.4 (19.5)</td>
<td>126.4 (11.0)</td>
</tr>
<tr>
<td>SolPM</td>
<td>49.9 (23.2)</td>
<td>81.6 (24.6)</td>
<td>115.4 (14.4)</td>
</tr>
<tr>
<td>VPN</td>
<td>68.6 (19.5)</td>
<td>75.5 (21.6)</td>
<td>93.0 (10.6)</td>
</tr>
</tbody>
</table>

RSP, respirable suspended particles; SolPM, particle solanesol; VPN, vapour-phase nicotine.
ventilation systems. Indeed, mean SHS levels in the bar areas of mechanically ventilated pubs were slightly higher than in smoking areas. This could be due to high levels of smoking at the bar or poor ventilation arrangements that encourage smoke drift towards the bar. A visual inspection of the mechanically ventilated pubs at the time of data collection indicated that the latter explanation is plausible, with air inlets frequently located in the public smoking areas and extract vents often located in central areas near the bars. In contrast, extractor fans are located on exterior surfaces, which tend to be in public areas away from the central bar areas, thus promoting airflow away from the bar. Improvements in the design and installation of ventilation systems may be capable of improving air quality. However, further work is required to demonstrate this.

Limitations
The paucity of data about the configuration of the pubs, type of ventilation system and occupancy and smoking during the measurement periods limits the validity of the comparison of SHS levels between pubs by type of ventilation. Follow-up research being undertaken by the authors across pubs in the north-west of England will include data on occupancy and smoking rates. We also lacked data on personal biomarkers of SHS exposure from staff and customers. However, previous papers have demonstrated high levels of such markers among bar staff.7,8 More recently, research from Ireland has shown dramatic reductions in salivary cotinine among non-smoking bar staff in Ireland following the introduction of smoke-free legislation.21

Conclusion
We found very high levels of SHS markers throughout a sample of UK pubs, despite some providing smoke-free areas and mechanical ventilation. Levels throughout the pubs, including in the non-smoking areas, were well above SHS levels found in domestic settings and other workplaces, which have been associated with adverse health effects. Levels in bar areas where pub staff spend most of their time were very high and little different from those in smoking areas.

We conclude that the English White Paper proposals will offer little protection to bar and pub staff from the occupational health hazard of passive smoking in premises where smoking is allowed. Unless a safe level of SHS can be defined, and measures like segregation and ventilation shown to achieve these safe levels, the only effective method for protecting hospitality staff and customers from SHS in pubs and bars is by providing smoke-free premises.

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Competing interests
None of the co-authors or their departments/organizations have any commercial or financial conflicts of interest to declare. P. R. Edwards is a former unpaid chair of North West ASH.

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References
1 Diethelm PA, Rielle JC, McKee M. The whole truth and nothing but the truth? The research that Philip Morris did not want you to see. Lancet 2005; 366: 86–92.

Table 4 Mean level (and standard error) of second-hand smoke markers in 23 smoking and non-smoking areas in pubs with restricted smoking – by ventilation type

<table>
<thead>
<tr>
<th>SHS marker (µg/m³)</th>
<th>Mechanical (n = 17)</th>
<th>Extractor (n = 37)</th>
<th>Natural (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smoking area (n = 11)</td>
<td>Non-smoking area (n = 6)</td>
<td>Smoking area (n = 25)</td>
</tr>
<tr>
<td>RSP (PM₂.₅)</td>
<td>87.9 (18.2)</td>
<td>78.7 (22.2)</td>
<td>107.2 (13.5)</td>
</tr>
<tr>
<td>SolPM</td>
<td>51.0 (20.9)</td>
<td>48.3 (25.8)</td>
<td>85.5 (15.8)</td>
</tr>
<tr>
<td>VPN</td>
<td>56.7 (17.0)</td>
<td>27.0 (21.7)*</td>
<td>88.0 (12.0)*</td>
</tr>
</tbody>
</table>

RSP, respirable suspended particles; SHS, second-hand smoke; SolPM, particle solanesol; VPN, vapour-phase nicotine.
*The mean natural log of VPN was lower in non-smoking areas than in smoking areas (p < 0.001).
†The mean natural log of VPN was higher in areas with extractor fans than in areas with mechanical ventilation (p = 0.030).


20 Drope J, Bialous SA, Glantz SA. Tobacco industry efforts to present ventilation as an alternative to smoke-free environments in North America. Tob Control 2004; 13(Suppl 1): i41–i47.