PASSIVE SMOKING EXPOSURE AND RISK FOR IRISH BAR STAFF

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ABSTRACT
Ventilation failed to protect the health of bar staff. Carbon monoxide from environmental tobacco smoke (ETS-CO) measured in 14 bars in Galway, Ireland showed mean ETS-CO levels of 6.36 ppm (St. Dev. 4.36 ppm), with median levels at 6.00 ppm. Peak CO exceeded 63 p.p.m. in two premises. Passive smoking at the level of 6 ppm of ETS-CO for 30 minutes is known to induce as much dysfunction of the coronary circulation as that in smokers. Exposure to ETS-CO levels equivalent to 6 ppm for 40 years carries an estimated combined excess mortality risk from heart disease and lung cancer sufficient to cause the premature death of 1 out of 5 bar staff. Of the 78,000 workers in alcohol-licensed premises throughout Ireland in 1999, about 56,000 were employed in pubs. Assuming only half are employed full-time, this translates into an estimated 150 deaths per year in the full-time pubworkers alone.

INDEX TERMS
Passive smoking, Environmental Tobacco smoke, Carbon monoxide, Risk, Health effects

INTRODUCTION
Passive smoking has been identified as a cause of cancer, cardiovascular disease and stroke in non-smokers with the risk of illness increasing with length of exposure (NCI, 1999; Bonita, et al., 1999). For catering workers, the increased risk of developing cancer has been estimated to be on average more than 50% that of the general public, with air measurements suggesting such workplaces to be as much as 6 times more polluted with environmental tobacco smoke (ETS) than offices (Siegel 1993). Bergman et al (1996), suggests waitresses to have the highest mortality rate for any occupational group in California, including four times the lung cancer rate. Eisner et al.(1998) studied the association between ETS exposure and respiratory symptoms in bartenders before and after California’s prohibition on smoking in all bars and taverns in 1998. After ETS exposure completely ceased, objective measures of pulmonary function in both smokers and nonsmokers showed a marked 5% to 7% improvement after only one month of smoke-free air. Eisner et al. (1998) conclude that establishment of smoke-free bars and taverns was associated with improvement of respiratory health. In the only published European study of bar workers, Jarvis et al (1992) studied salivary cotinine in 42 non-smoking bar staff in 27 pubs in London and Birmingham. Jarvis et al (1992) reported a median salivary cotinine level of 7.4 ng/ml, similar to that found by Jarvis (1992) in English pubworkers. Repace (2002) estimated that, for an 8-hr ETS exposure 7.4 ng/ml equated to 6 ppm of ETS-CO. Otsuka et al. (2002) in a study of 28 healthy young nonsmoking women, found that inhaling 6 ppm of ETS-CO for 30 minutes induces dysfunction of the coronary circulation as much as that in smokers. In an earlier study of pubs, Jarvis et al (1983) measured ETS-CO levels of 13 ppm which they concluded were ‘towards the extreme end of acute natural exposure.

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METHODS
Carbon monoxide was used as an atmospheric marker for ETS. A Neotronics Minigas 4 with datalogger (Zellweger Analytics Ltd. Bishops Stortford, Hertfordshire, England) was used to obtain environmental CO samples both grab and continuous. Grab (spot) samples of environmental CO were obtained from 6 bars. The grab environmental CO samples were obtained from a walk-through of each bar at 3 intervals (beginning, middle, and end) during a 2/3 hour period. The grab samples were taken at busy times (with occupancy ranging from 5-70% and all venues exceeding 50% occupancy at some point during the sampling period). Background CO measurements were performed outdoors for 5 minutes before each monitoring period and averaged. Continuous sampling of environmental CO from bars during 9 sessions from 8 venues that ranged in size from 300 to 800 square feet. Continuous samples were obtained over 2/3 hour period in a central area of the bars, away from strong drafts. The continuous monitoring samples were taken during busy shifts (with occupancy ranging from 15-95% and exceeding 50% at some time during the shift) apart from two venues which had occupancy rates between 10-15%. A total of 14 venues were sampled, with 5 pubs being measured twice. A questionnaire was answered by 152 controls and 79 bar personnel concerning their occupation and duration of employment. Bar personnel and controls were also queried for their health and safety concerns and average weekly exposure to ETS.

RESULTS
A general rise in environmental carbon monoxide values over the monitoring periods was found in both grab sampling and the continuous monitoring (with the exception of one sample). Continuous monitoring samples showed that drops in CO values were associated with observations of either increased ventilation (such as doors being opened due to customer traffic) or reductions in occupancy (such as prior to closing time). Analysis of all the graphs of results from both methods reveals that in only one case was the CO level maintained at background levels. In this particular case this was probably due to the combination of the relatively high background CO (6 p.p.m.) reading taken on a busy street at the front of a premises and the low ambient CO in the rear bar area that was sampled. Moreover the ventilation was so overwhelmed in two premises such that peak readings of 63 p.p.m. and 64 p.p.m. were reached. Both these had relatively low ceilings (8 and 7.5 feet) and the lowest ceiling heights of all venues sampled. In addition their ventilation ducts were situated at ceiling level and at the time these peaks occurred entrance doors and windows were closed. Figures 1 and 2 illustrate the data.
Table 1. Occupation

<table>
<thead>
<tr>
<th>Occupation</th>
<th>No.</th>
<th>%*</th>
<th>BAR PERSONNEL</th>
<th>No.</th>
<th>%*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative</td>
<td>27</td>
<td>17.8</td>
<td>Bar owner</td>
<td>20</td>
<td>25.3</td>
</tr>
<tr>
<td>Clerical</td>
<td>62</td>
<td>40.8</td>
<td>Bar manager</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Dental</td>
<td>0</td>
<td>0</td>
<td>Bar worker</td>
<td>35</td>
<td>44.3</td>
</tr>
<tr>
<td>Maintenance</td>
<td>1</td>
<td>0.7</td>
<td>Hotel owner</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Medical</td>
<td>12</td>
<td>7.9</td>
<td>Hotel bar manager</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Paramedical</td>
<td>11</td>
<td>7.2</td>
<td>Hotel bar worker</td>
<td>4</td>
<td>5.1</td>
</tr>
<tr>
<td>Other professional health</td>
<td>34</td>
<td>22.4</td>
<td>Other</td>
<td>3</td>
<td>3.8</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>3.3</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>TOTAL</td>
<td>152</td>
<td></td>
<td></td>
<td>79</td>
<td></td>
</tr>
</tbody>
</table>

*Valid percentage

Figure 1. Continuous monitor CO trace for Pub #4, a large bar and music venue, two entrance doors, ducted ventilation to rear. Ave. ceiling height 13 ft, floor area 750 ft². Ave. # occupants: 128 (SD 7); ave. # active smokers: 7.3 (SD 1.5) for 3 samples. 1st half hour, entrance doors fixed open; last hour, doors reopened and ventilation on. Ave. outdoor background is 2ppm. Estimated ave. ETS-CO is 8 ppm.

Figure 2. Left ordinate: log-probability plot of mean ETS-CO values (n = 19) for 14 pubs (5 venues measured twice). Mean estimated ETS-CO is 6.36 ppm. Regression fit shown (R²=0.97). All data represent 40 minute averages. Right ordinate: estimated 40 year working life-time excess risk of combined mortality from heart disease and lung cancer for workers exposed for a typical 40-hr work week. >20% of workers are estimated to die from ETS.
Risk Analysis: Using the methods of Repace (2002), corresponding to the median ETS-CO level of 6.00 ppm, the estimated median ETS-RSP = 247 ETS-CO = (247)(6) = 1482 g/m³. Assuming a background level of 15 g/m³, for an 8-hr daily exposure this violates the U.S. 24-hr National Ambient Air Quality Standard for respirable particle pollution (PM_{2.5}) of 65 g/m³ by a factor of 23. The estimated median salivary cotinine (8-hr workday) = 0.005 ETS-RSP = (0.005)(1542) = 7.4 ng/ml, similar to that found by Jarvis (1992) in English pubworkers in 1992. Otsuka et al. (2002) found that passive smoking equivalent to 6 ppm of ETS-CO for 30 minutes impairs the coronary circulation of nonsmokers by 23%, to a level equal to that in smokers. This may be compared to the mean 40 minute ETS-CO for the 14 pubs as indicated on the left ordinate axis in Figure 2. Repace et al. (1998) estimate that an average saliva cotinine of 7.4 ng/ml for 40 years carries a combined mortality risk from heart disease and lung cancer of (7.4/0.4)(1.1%) = 20%. This median risk corresponds to an excess premature mortality expected for one out of five barworkers exposed at this level. The estimated risk corresponding to the ETS-CO level in Figure 2 is shown on the right ordinate axis. According to a Survey of Licensed Premises (Scott, 2000), there were about 78,000 workers in liquor-licensed premises throughout Ireland in 1999, of whom about 56,000 were employed in pubs. If we estimate that 50% of these, or 28,000 are full-time, at the mean exposure of 6.36 ppm ETS-CO, this translates into an estimated (20%)(28,000)/40 years = 150 deaths per year in the full-time workers alone. Adding in the part-time workers would raise this figure significantly.

DISCUSSION

Risk Analysis: Table 1. shows that clerical staff were the largest proportion (40.8%) of Western Health Board respondents. Most bar personnel were bar workers (44.3%) followed by bar owners (25.3%). Nearly for four out of ten bar personnel (38%; 30 cases) had been employed for over 10 years. This is a little surprising for what is often assumed to be relatively short-term job. However, this figure may be a result of nearly 35% of respondents being either bar owners or managers whom have obviously made a career in the licensed trade. Table 2 below shows that for self reported exposure to ETS, bar personnel experienced greater exposure to smoke than controls in home, leisure and most significantly, work environments (41.34 hours compared to 1.5 hours). Furthermore, the average total weekly exposure for bar personnel was 71.4 hours contrasting starkly with that of the control group with 12.3 hours per week.
Jarvis (in press) reports that the mean and median salivary cotinine in a probability sample ($n = 7123$) of the English population were 0.86 ng/ml and 0.40 ng/ml respectively. For a subset of 44 London bar staff, Jarvis (in press) reported a mean and median level of 6.16 ng/ml and 3.65 ng/ml respectively. The ratio of the means is (6.16/0.86) = 7.2 and the ratio of the medians is (3.65/0.4) = 9.1. The estimated mean and median for the Irish bar staff based on the ETS-CO levels are 7.84 ng/ml and 7.4 ng/ml respectively. It appears that the Galway bar staff have an mean ETS exposure that is about (7.84/0.86) = 9.1 times the average English person, and (7.84/6.16) = 27% higher than the London bar staff, and a median exposure in the ratio of (7.4/3.65) which is double. The mean ETS exposure of the Galway pubworkers is estimated to be (7.84/0.86) = 9.1 times that of the average English person, and the ratio of the medians is (7.4/0.4) = 18.5-fold. As Jarvis (in press) observes, another way of comparing ETS exposure in bar staff with that in the general population is to examine the relative probability of finding high levels of exposure. Jarvis takes a salivary cotinine level of 5 ng/ml or above as indicative of “extremely high exposure,” as a value this high was observed in under 3% of all nonsmokers in the 1998 Health Survey for England. By comparison, a salivary cotinine level of 5 ng/ml corresponds to an ETS-CO level of (5/7.4)(6.00) = 4 ppm ETS-CO for an 8-hr exposure day. From Figure 2, approximately 70% of Galway pubworkers exceeded 4 ppm ETS-CO.

CONCLUSION AND IMPLICATIONS
Ventilation is incapable of controlling environmental tobacco smoke (ETS). The U.S. ASHRAE Standard, recognized internationally, recommends 30 cubic feet per minute per occupant for bars. At an occupancy of 70 persons per 1000 ft$^2$ and a 10.5 foot ceiling, this yields 12 air changes per hour, equivalent to the Irish Health Officers’ Association recommendation (EHOA, 1995). Despite these high recommended rates of air exchange in accord with international standards, bar ventilation systems were ineffective in controlling CO and thereby the gas/vapor phase of tobacco smoke. What is more two busy, poorly ventilated premises recorded unprecedented levels of CO (63 and 64 ppm suggesting that barworkers are at extreme risk of cardiovascular disease, which accounts for 90% of the risk of ETS exposure. Barworkers appear to suffer far greater exposures and risks than members of the general population with Galway pubworkers suffering exposures greater than 97% of English nonsmokers. We estimate that for 28,000 full-time pubworkers in Ireland, at least 150 deaths per year from passive smoking.

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