



Carcinogen and Nicotine Exposure in Hospitality Workers Before and After the State Comprehensive Smoking Ban University of Minnesota

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Background

Environmental Tobacco Smoke (ETS) has been an increasing public health concern over the past several years. Legislation has been passed in some communities restricting the amount of ETS exposure in certain work and public venues, but restaurant and bars have often been exempt from these regulations. As of October 1, 2007 Minnesota passed a bill to provide smoke-free public places, including bars and restaurants

The intent of this study was to assess the extent of the exposure to carcinogens (or cancer causing agents) and nicotine experienced by employees, in particular bar and restaurant employees, prior to smoke-free legislation and after the legislation went into effect. A carcinogen constituent of ETS is the *N*-nitrosamine, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK). Urinary metabolites of NNK, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) and its glucuronides (NNAL-Glucs) are excellent biomarkers of human uptake of this tobacco-specific carcinogen and NNAL, like NNK, is a potent pulmonary carcinogen. The outcome measures will include total NNAL (NNAL plus NNAL-Gluc) as well as total cotinine (cotinine plus cotinine-Glucs), a metabolite of nicotine and an indicator of amount of nicotine absorbed in the body.

Methods and Procedures

Non-smoking bar and restaurant (hostesses, bartenders and wait staff) and bowling alley employees were recruited to participate in this study. Subjects (N=24) were recruited from the following communities: 1) Thief River Falls, 2) Duluth, 3) St Cloud, 4) Red Wing and 5) Moorhead. Subjects contacted the University of Minnesota Tobacco Use Research Center for a phone screening to verify they were eligible for the study. Subjects were considered eligible if they reported that they were: a) a never smoker or an ex-smoker who is at least 6 months abstinent; b) living in a smoke-free household; c) working at least a 6 hour shift during urine collection period; d) not using any nicotine containing products and agreed to abstain from use of all tobacco products.

Subjects were mailed a consent form and questionnaires about their environmental tobacco smoke exposure, their own tobacco use behavior and

health status. The consent form and these questionnaires, which only had subject identification numbers, were returned to the Tobacco Use Research Center in the self-addressed envelope. In addition, subjects were mailed two urine cups also labeled with a subject identification number and other questionnaires. These questionnaires, which were to be completed the day of the urine collection, inquired about the amount of smoke exposure in the workplace, the extent of smoke exposure outside the workplace, and use of any nicotine containing products.

Subjects collected their first morning urine sample in the labeled cup and completed the exposure questionnaires prior to the smoking ban after working a shift equal to or greater than 6 hours. The second first morning urine sample and questionnaires were collected 4 to 6 weeks after the smoking ban went into effect and after working a shift equal to or greater than 6 hours. These samples were brought to a designated contact in their community. Urine samples were frozen and then mailed to the University of Minnesota Tobacco Use Research Center, where they were assessed for total NNAL and total cotinine.

Results

The subject sample was comprised of 15 females and 9 males with a mean age of 29.6 (SD=11.6) years. Six subjects were ex-smokers and the others were non-smokers. Nineteen reported working at a bar and restaurant and 5 reported working at a bowling alley. The mean number of days per a week that they worked at these venues was 3.9 (SD=1.4, range = 2 to 6) and the mean hours per a work shift was 6.9 (SD = 1.3; range = 5 to 10). The mean percent of the hospitality venue that was considered a smoking section was 52.2% (SD = 35.5%, range = 10% to 100%). The mean number of hours spent in the smoking section was estimated to be about 6.1 (SD = 2.4, range 0 to 10 hours). Approximately 79.1% indicated that they are around smokers most or all the time at work, whereas 16.7% indicated exposure to environmental smoke outside of work some of the time (12.5%) or very often (4.2%).

Table 1 shows the extent of environmental smoke exposure at the workplace and outside the workplace just prior to the time of urine collection before and after the smoking ban went into effect.

Table 1: ETS exposure before and after the smoking ban

Amount of ETS exposure	Before Smoking Ban	After Smoking Ban
Duration of shift (Mean ± SD hours)	8.0 ± 2.1 (range 6 to 15)	7.7 ± 2.4 (range 4 to 15)
Time in smoking areas (Mean ± SD hours)	7.2 ± 2.9 (range 1 to 15)	---
Smoke exposure outside of work (Number of subjects)	4	1
Smoke exposure outside of work (Mean ± SD hours)	1.9 ± 2.8 (range 0 to 6)*	0.25

*The extent of exposure was 15 minutes, 35 minutes, 1 hour and 6 hours for the 4 individuals, respectively.

One subject erroneously collected the urine sample 3 days after the smoking ban went into effect, which may be insufficient for the clearance of cotinine from the body. Furthermore, this individual had levels that were higher than what would be expected for a non-smoker, which may have been the result of exposure to environmental smoke outside of work before (6 hours) and after (15 mins) the smoking ban. The data was analyzed with and without this data point and because no differences were found in the analyses, the subject's data was retained. Table 2 shows the total NNAL and total cotinine levels before and after the smoking bans. Significant reductions were seen for both variables, respectively.

Table 2: Median and mean difference (before minus after smoking ban) in urinary total cotinine and total NNAL

Variable	N	Median difference	Mean difference (95% confidence interval)	P-value**
Total Cotinine (ng/mL)	24	11.0	12.3 (5.7, 26.6)*	<0.001
Total NNAL (pmol/mL)	24	0.04	0.06 (0.03, 0.09)	<0.001

* Due to a skewed distribution for the difference in cotinine, the corrected geometric mean and confidence interval are reported using Cox's method (1).

** The p-value was calculated from the two-sided Wilcoxon signed-rank test
 Note: For the limit of detection, values of 0.0 and 1.0 were assigned for total NNAL and cotinine, respectively.

Table 3 shows the median percent decrease in urinary total cotinine and total NNAL levels. These values exceed 80%.

Table 3: The median percent decrease in urinary total cotinine and total NNAL

Variable	N	Median percent decrease
Total Cotinine (ng/mL)	24	83.3%
Total NNAL (pmol/mL)	24	84.9%

Approximately, 54.2% (13/24) of the workers showed at least a 50% reduction in total NNAL, with 87.5% (21/24) showing at least a 50% reduction in total cotinine.

Conclusions

The results of this study show that the comprehensive smoking ban has had a significant impact in reducing exposure and uptake of carcinogens and nicotine

in hospitality workers. Although the extent of exposure to these toxic agents is dramatically less than in cigarette smokers, protecting our workers (and patrons) from known cancer causing agents, which has been demonstrated to be present in the urines of these workers prior to the smoking ban, should continue to be a high priority.

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Reference

(1) Zhou XH, Gao S. Confidence Intervals for the Log-Normal Mean. *Statistics in Medicine*. Vol 16, 783-790 (1997).