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The impact of Michigan's Dr Ron Davis smoke-free air law on levels of cotinine, tobacco-specific lung carcinogen and severity of self-reported respiratory symptoms among non-smoking bar employees

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ABSTRACT

Objective To determine the impact on bar employee's health and exposure to secondhand smoke (SHS) before and after the implementation of Michigan's Dr Ron Davis smoke-free air law that went into effect on 1 May 2010, prohibiting smoking in places of work, including bars.

Methods This study used a pre/postintervention experimental design. The setting was bars in 12 Michigan counties. Subjects were bar employees, recruited through flyers and individual discussions with local health department staff. Participants completed a screening questionnaire to determine eligibility. A total of 40 eligible employees completed a demographic survey, provided urine samples for analysis of cotinine and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) and completed questionnaires on respiratory and general health status 6 weeks before and 6–10 weeks after the law went into effect. The main outcome measures were urine samples for total cotinine and total NNAL and data from a self-administered respiratory and general health status questionnaire collected during the pre-law and post-law study periods.

Results There was a significant decrease in the mean cotinine levels from 35.9 ng/ml to a non-quantifiable value ($p<0.001$), and there was a significant reduction in the mean NNAL level from 0.086 pmol/ml to 0.034 pmol/ml ($p<0.001$) 2 months after implementation of the law. There was also a significant improvement in all six self-reported respiratory symptoms ($p<0.001$) and general health status ($p<0.001$).

Conclusions The reduction in the SHS biomarkers cotinine and NNAL and reported improvement in respiratory health demonstrates that the Michigan smoke-free workplace law is protecting bar employee health.

INTRODUCTION

Despite significant progress in tobacco control, millions of adults continue to be exposed to secondhand smoke (SHS) in their places of work.[1] Workers in the hospitality industry, such as waiters, waitresses and bartenders, are of particular concern because these workers have the highest rates of lung cancer compared to other occupations.[2] This evidence of increased disease risk among non-smokers exposed to SHS in the workplace has led to the passage of laws that ban smoking in indoor work environments.[3] These laws protect a large majority of workers from indoor SHS.[4] Smoke-free workplace policies are the only effective way to eliminate secondhand smoke exposure in the workplace.[5]

A total of 29 states in the USA, and Washington, DC and Puerto Rico have passed smoke-free workplace laws that include bars and restaurants; [6] Michigan was the 25th state to enact a state smoke-free air law. Although numerous states have adopted smoke-free workplace laws, relatively few have evaluated the health impact of these laws.[7–13] We conducted an evaluation of the Michigan smoke-free workplace law, referred to as the Michigan Secondhand Smoke Exposure Study, to determine the impact of the law on employee health, specifically changes of urinary total cotinine and total 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) levels and reported respiratory and general health status among bar employees before and after the smoke-free law went into effect.

METHODS

Subjects

Local health department staff were asked to find stand-alone bars, which allowed smoking before the law went into effect, in 12 of the most populous counties in the state and recruit up to 6 bar employees. Local health department staff distributed flyers, including information about the study, at two to three non-randomly selected bars in each county. Individuals who were interested in the study were asked to complete a screening questionnaire to determine if they met the eligibility requirements. Eligible individuals were asked to sign an informed consent if they agreed to participate in the study.

Inclusion criteria for participation included individuals who: (1) were age 18 years or older; (2) had never smoked or, if they were ex-smokers, had quit at least 6 months prior to this study; (3) lived in a smoke-free household; (4) worked at least one 6 h shift in a bar during the urine collection period; (5) planned to stay at the same job for the next 4–6 months, and (6) were not using any nicotine replacement products (ie, gum, patch, lozenge, or inhaler) or smokeless tobacco and agreed to abstain from all tobacco products during data collection. Exclusion criteria included exposure to SHS in environments other than work. We defined smokers as persons who smoked every day or occasionally.

Measurements

We measured level of exposure to SHS by assessing cotinine and NNAL levels as these are valid and

reliable biomarkers for measuring level of exposure to secondhand smoke.[14–18] The same participants provided a pre/post intervention urine specimen for total cotinine and total NNAL analysis and questionnaire assessing respiratory and general health status. Each participant also completed a demographic questionnaire. The same participants completed the urine specimen collection and respiratory and general health questionnaire approximately 4–6 weeks before and approximately 6–10 weeks after the law went into effect. Respiratory health was measured by asking participants to rate the following respiratory symptoms using an ordinal Likert-type scale from not present (1) to severe (5) for each of six symptoms: morning cough, daytime cough, phlegm production, shortness of breath, wheezing and allergic symptoms. We measured general health status by asking participants to rate their general health status on a Likert-type scale from worst (1) to best (10). The participant screening, demographic and respiratory health questionnaires used in this study were validated and provided by the University of Minnesota, Masonic Cancer Center.

Laboratory methods

Participants were asked to collect a urine sample first thing after their 6 h shift and continue to collect until the first morning void. Participants were asked to keep the urine samples refrigerated until they were mailed in an overnight packet to Western Slope Laboratory, LLC. Completed participant demographic and respiratory health questionnaires were returned to the Michigan Department of Community Health, Tobacco Section. Participants received a monetary incentive for each urine sample received and analysed. Samples were analysed for total cotinine by liquid chromatography/tandem mass spectrometry (LC/MS/MS) (lower limit of detection 1 ng/ml, lower limit of quantitation 5 ng/ml) at Western Slope Laboratory, LLC and total NNAL analysis was conducted at the University of Minnesota, Masonic Cancer Center laboratory.

Analysis

We entered and analysed the data in SPSS V.15 (SPSS, Chicago, Illinois, USA). We calculated paired-samples t tests to determine if there were significant differences in mean cotinine and NNAL levels. We calculated the Wilcoxon rank-sum test to determine if there were significant differences in respiratory symptoms and general health status before and after the smoke-free air law went into effect.

Human participant protection

Our study protocol was approved by the Michigan Department of Community Health, Institutional Review Board.

RESULTS

A total of 46 bar employees, ages 21–73, were eligible to participate and were enrolled in the study from 12 of Michigan's most populous counties. Six participants were unable to provide follow-up post-law urine samples and were excluded from the study (lost to follow-up rate = 13%). These six participants were similar to those who completed the study in terms of gender, age, baseline respiratory symptoms, general health and years worked in the bar.

The sample size for this study was 40 participants. The majority of the participants (70%) were women, and the mean age of participants was 44.8 years (SD, 14.7). The majority (95%) of participants were white; one participant was Arab–American and one Latino. Two-thirds of the employees worked as bartenders, and the mean number of years employees worked in the same establishment was 10.9 years (SD, 10.6).

There was a significant decrease in total cotinine and total NNAL levels among participants before and after the smoke-free law went into effect. There was also a significant decrease in all six reported respiratory symptoms before and after the smoke-free law went into effect. In addition, participants reported a significant improvement in general health status before (M=7.20) (SD, 1.42) and after the law went into effect (M=8.23) (SD, 0.86), (t (39)=−5.272, p<0.001) (table 1).

DISCUSSION

Our study demonstrated that cotinine levels and NNAL levels were significantly reduced among bar employees 2 months after the Michigan state smoke-free air law was implemented. Cotinine was decreased to unquantifiable levels among all bar employees, and NNAL levels among bar employees were reduced by 60%. In addition, the majority of bar employees reported a significant improvement in general health and in six respiratory symptoms after the smoke-free law went into effect.

Our findings are similar to other studies that have found decreased cotinine levels, decreased NNAL levels and reported improvement of respiratory symptoms among hospitality workers after the implementation of state smoke-free workplace policies or laws.[11–17] However, these individual studies did not assess all of these measures associated with exposure to SHS simultaneously. Our study assessed total cotinine, total NNAL, respiratory symptoms and general health status among bar employees. Moreover, our study had a relatively good sample size due to the fact that local health department staff actively recruited potential participants at the bars where they worked.

There are some limitations to our study. First, our study did not employ a control group and is, in essence, a single-arm uncontrolled trial. However, the results were so fast and of such large magnitude that it seems unlikely that anything other than the intervention could have caused them. Additionally, our study had a small, convenience sample of only 40 participants and, on average, only 3 participants from each county, so that participants were not necessarily representative of the general population of bar employees in their respective counties or the general population of bar employees in Michigan.

Despite these limitations, our study demonstrated that Michigan's smoke-free air law is protecting the health of bar

Table 1 Differences in urine cotinine, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) levels and self-reported respiratory symptoms before and after implementation of state smoke-free air law, bar employees, Michigan secondhand smoke exposure study, 2010

	Pre-law mean (SD)	Post-law mean (SD)	p Value
Biomarker			
Cotinine, ng/ml	35.9 (17.4)	<5 ng/ml	<0.001*
NNAL, pmol/ml	0.087 (0.065)	0.035 (0.033)	<0.001*
Respiratory symptom:†			
Allergic symptoms	2.5	1.5	<0.001‡
Wheezing	1.3	1.1	0.053‡
Shortness of breath	1.7	1.4	0.048‡
Phlegm production	1.8	1.4	0.021‡
Daytime cough	1.5	1.2	0.018‡
Morning cough	1.5	1.1	0.003‡

*p Values derived from the paired samples t test.
†Values for pre-law and post-law means are based on a five-point likert-type scale where 1=not present to 5=severe.
‡p Values derived from the Wilcoxon rank-sum test for paired observations.

What this paper adds

- Previous studies have found a decrease in cotinine and tobacco-specific lung carcinogen as well as improved self-reported respiratory symptoms among bar employees after the implementation of a state smoke-free air law that prohibits smoking in bars and restaurants.
- Our study is the first to assess multiple aspects of employee health simultaneously, including pre-law and post-law changes in cotinine levels, a tobacco-specific lung carcinogen and self-reported health outcomes among bar employees.
- In addition, our study uniquely involved collaborative efforts between the state tobacco control program and local health departments.
- Our findings add to the evidence that bar employees have decreased total cotinine and total NNAL levels and reported improvement in respiratory health symptoms after implementation of a state smoke-free air law that prohibits smoking in bars and restaurants.

employees. Our findings of dramatically decreased cotinine and NNAL levels over a period of only 10–16 weeks and improvements in reported respiratory symptoms and general health status contribute to the literature that demonstrate the positive impact that state smoke-free air laws can have on employee health. Our findings may be useful to other states or localities that are interested in evaluating the health impact of smoke-free legislation.

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Competing interests None.

Ethics approval Michigan Department of Community Health Institutional Review Board.

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