

Evaluating Effects of Statewide Smoking Regulations on Smoking Behaviors Among Participants in the Survey of the Health of Wisconsin

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ABSTRACT

Background: Studies have shown that laws banning smoking in public places reduce exposure to secondhand smoke, but the impact of such laws on exposure to smoke outside the home and on household smoking policies has not been well documented. The goal of this study was to evaluate the effects of 2009 Wisconsin Act 12, a statewide smoke-free law enacted in July 2010, among participants in the Survey of the Health of Wisconsin (SHOW).

Methods: Smoking history and demographic information was gathered from 1341 survey participants from 2008 to 2010. Smoking behaviors of independent samples of participants surveyed before and after the legislation was enacted were compared.

Results: The smoking ban was associated with a reduction of participants reporting exposure to smoke outside the home (from 55% to 32%; $P < 0.0001$) and at home (13% to 7%; $P = 0.002$). The new legislation was associated with an increased percentage of participants with no-smoking policies in their households (from 74% to 80%; $P = .04$). The results were stronger among participants who were older, wealthier, and more educated.

Conclusion: Smoke-free legislation appears to reduce secondhand smoke exposure and to increase no-smoking policies in households. Further research should be conducted to see if these effects are maintained.

INTRODUCTION

Laws banning smoking in public places, passed in parts of Canada and the United States as well as in several European countries, have been shown to reduce secondhand smoke exposure in public places and to improve overall air quality.¹⁻³

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However, the evidence on the effects of smoke-free environment laws on exposure to secondhand smoke in the home^{1,4} and on active smoking^{1,5-7} is more limited. Continued study of the effects of smoking bans is therefore important in order to better understand the impact of these laws on reducing exposure to tobacco smoke and on changing smoking behaviors.

While the entire United States is not under a 100% smoke-free law, states such as Wisconsin and 22 others have seen the implementation of such laws in recent years. Like the rest of the United States, Wisconsin suffers the devastating effects of tobacco smoke with approximately 7700 deaths (or about 15% of all deaths) being associated with tobacco use

each year.⁸ In an attempt to minimize the effects of secondhand tobacco smoke, on July 5, 2010 the state government enacted 2009 Wisconsin Act 12, banning smoking in public places and places of employment across the entire state. A study conducted by the University of Wisconsin's Carbone Cancer Center already has demonstrated that this law improved air quality in Wisconsin bars and restaurants by reducing the mean particulate matter detected in the air by 92%.⁹ The effects of the law on reducing secondhand smoke exposure and on changing smoking behaviors among Wisconsin residents, however, has not yet been studied.

We used data from the 2008-2010 waves of the Survey of the Health of Wisconsin (SHOW) to study the effects of 2009 Wisconsin Act 12 on smoking behaviors of Wisconsin residents. We hypothesized that those surveyed after the enactment of 2009 Wisconsin Act 12 on July 5, 2010 would have a lower smoking prevalence, lower exposure to smoke outside and inside the home, a higher desire to quit smoking, and

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increased no-smoking policies in their households than those surveyed prior to the enactment of the ban. If the effects of 2009 Wisconsin Act 12 are positive, such results could imply that legislative smoking bans could be key components in future attempts made to reduce the poor health outcomes associated with tobacco use and exposure to tobacco smoke.

METHODS

Data Collection

SHOW is an annual survey of the health status of a randomly selected representative sample of Wisconsin residents and communities that began in June 2008. Study methods previously have been described.¹⁰ In brief, a 2-stage cluster sampling method was used to randomly select households and recruit adult study participants (21-74 years old) each year from various communities across the state. To increase participation and awareness, a public relations campaign was launched 6 to 8 weeks before recruitment was scheduled to begin at a particular location. The participants were surveyed about their health, demographic, behavioral, lifestyle, and housing characteristics as well as their smoking behaviors and usual exposure to tobacco smoke. The smoking questionnaire included questions about the length and extent of tobacco use, exposure to secondhand smoke, as well as quit attempts and strategies used to stop smoking.

A smoking history was obtained from 1341 SHOW participants from 2008 to 2010. This information allowed evaluation of the effects of the statewide smoking ban (2009 Wisconsin Act 12) on smoking behaviors by comparing the behaviors of those surveyed before and those surveyed after the law's enactment on July 5, 2010.

To determine the effect of the law to its maximum potential, participants who lived in an area with a workplace or complete public smoking ban prior to the statewide ban were excluded from the analysis. A report by the Wisconsin Department of Health Services titled *Wisconsin Tobacco Facts 2009*,¹¹ listing which communities had smoke-free policies before 2010, was used to assign participants as being exposed or not exposed to a local smoking ban prior to 2009 Wisconsin Act 12. If a particular community within a Census Block Group had a local ban in place before 2010, then all of the communities within

Table 1. Selected Characteristics of Participants Exposed and Not Exposed to a Local Smoking Ban Before 2010, Survey of the Health of Wisconsin, 2008-2010.

	Exposed		Not Exposed		P value
	n	%	n	%	
Smoking status					
Never smokers	246	56.7	471	52.0	0.27
Former smokers	114	26.3	268	29.6	
Current smokers	74	17.1	167	18.4	
Exposed to smoke outside home	181	44.4	377	45.6	0.72
Exposed to smoke at work	37	9.1	92	10.8	0.41
Exposed to smoke at home	38	8.9	92	10.3	0.49
Had strict smoking policy in household	370	81.3	759	76.4	0.04
Age					
21-40-year-old age group	229	45.4	317	29.7	<0.0001
41-60-year-old age group	187	37.1	530	49.6	
61-74-year-old age group	88	17.5	221	20.7	
Family income					
<\$30,000 per year	127	26.4	256	25.0	0.005
\$30,000-\$59,999 per year	122	25.4	336	32.8	
≥\$60,000 per year	232	48.2	431	42.1	
Education					
High school education or lower	104	20.7	344	32.2	<0.0001
Some college education or higher	398	79.3	723	67.8	

that Census Block Group were assigned as having a smoking ban prior to the enactment of the statewide ban. Survey participants' addresses were linked to the smoking ban status of their Census Block Group and 273 participants (20.4% of original 1341) with a ban prior to 2009 Wisconsin Act 12 were excluded from the analysis. The sample size after this exclusion was reduced to 1068 participants with 634 being surveyed before the enactment of 2009 Wisconsin Act 12 and 434 after.

Data Analysis

SAS software¹² was used to conduct the data analysis. For all analyses shown, a SHOW study enrollment date before or after July 5, 2010 was used to place participants into the before or after statewide ban groups. Chi-square tests were used to compare proportions and two-tailed *t* tests were used for comparison of means. Appropriate sample weighting was applied based on survey strata and cluster structure. Logistic regression models were used to estimate crude and adjusted odds ratios of exposure to smoking variables comparing SHOW participants recruited after and before the state smoking ban. The results were stratified by age, income, and educational level to determine whether the effects of the law varied depending on these factors.

RESULTS

Table 1 provides select characteristics of the SHOW participants exposed and not exposed to a smoking ban before 2010. It demonstrates that among those not exposed to a smoking

Table 2. Comparison of Smoking Behaviors and Exposure to Tobacco Smoke Before and After the Enactment of Wisconsin Act 12, Survey of the Health of Wisconsin, 2008-2010^a

	Total (n)	Before Ban ^b	After Ban ^b	P Value
Smoking status				
Never smokers	906	52% (271)	52% (200)	0.8
Former smokers		30.1% (157)	28.8% (111)	
Current smokers		17.9% (93)	19.2% (74)	
Exposed to smoke outside home	826	55.5% (264)	32.3% (113)	<0.0001
Mean number of cigarettes smoked				
among current smokers	162	15.2 (93)	14.2 (69)	0.6
Exposed to smoke at work	849	12.2% (59)	9% (33)	0.1
Exposed to smoke at home	894	13% (67)	6.6% (25)	0.002
Current smokers who want to completely quit	160	87.5% (77)	83.3% (60)	0.5
Current smokers who Seriously considered quitting within next 6 months	151	80.7% (67)	77.9% (53)	0.7
Had strict smoking policy in household	993	74% (416)	79.6% (343)	0.04

^aParticipants that were exposed to a local smoking ban before 2010 were excluded.

^bNumbers given in parenthesis correspond to the n values of each category.

Table 3. Unadjusted Odds Ratios Comparing Smoking Behaviors and Exposure to Tobacco Smoke After vs Before the Enactment of Wisconsin Act 12, Survey of the Health of Wisconsin, 2008-2010^a

	Total (n)	Odds Ratio (95% CI)
Being current smoker	906	1.08 (0.76-1.55)
Participants being exposed to smoke outside home	826	0.31 (0.22-0.44)
Participants being exposed to smoke at work	849	0.60 (0.41-0.88)
Participants being exposed to smoke at home	894	0.41 (0.23-0.71)
Smokers who want to completely quit smoking	160	0.60 (0.25-1.46)
Smokers who considered quitting within next 6 months	151	1.20 (0.70-2.04)
Participants having a strict ban in the home	993	1.43 (0.96-2.13)

^a Participants that were exposed to a local smoking ban before 2010 were excluded.

Abbreviation = CI, confidence interval.

ban before 2010, 52% were never smokers, 29.6% were former smokers, and 18.4% were current smokers. In the same group, 45.6% reported exposure to smoke outside the home, 10.8% at work, and 10.3% at home. On the other hand, among those who were exposed to a law prior to 2009 Wisconsin Act 12, 56.7% were never smokers, 26.3% were former smokers, and 17.1% were current smokers. In this group, 44.4% were exposed to smoke outside the home, 9.1% at work, and 8.9% at home. The *P* values for the comparison of exposed vs not exposed groups with regards to smoking status and exposure to secondhand smoke are shown.

Table 2 shows the comparison of smoking behaviors and exposure to tobacco smoke among participants surveyed before and after the enactment of 2009 Wisconsin Act 12. The proportion of survey participants who reported exposure to smoke outside the home decreased from 55% to 32% after

the statewide ban ($P < 0.0001$). A similar reduction was observed for exposure to smoke at home (13% to 7%; $P = 0.002$). Smoke-free legislation in Wisconsin also was associated temporally with an increase in the percentage of participants with strict no-smoking policies in their households from 74% to 80% ($P = 0.04$). The prevalence of smoking in participants recruited after the ban was slightly higher than among SHOW participants before the ban, but the difference was not statistically significant.

Table 3 provides the unadjusted odds ratios comparing smoking behaviors and exposure to tobacco smoke after vs before the enactment of 2009 Wisconsin Act 12. It shows that participants were 0.31 times as likely of being exposed to smoke outside the home after vs before the legislation, 0.60 times as likely of being exposed to smoke at work, and 0.41 times as likely of being exposed to smoke at home. Analyses adjusted for potential confounders (age, sex, income and education) resulted in virtually identical results as those presented in Table 3 (not shown).

Table 4 shows results stratified according to age, family income, and education. Overall, participants who were older, wealthier, and more educated tended to have larger improvements in their smoking behaviors and exposure to tobacco smoke as a result of the statewide ban. 2009 Wisconsin Act 12 was associated with decreased exposure of participants to smoke outside the home equally among all age groups, but it was associated with reduced exposure to smoke at work and at home to a larger extent among participants who were older. Participant exposure to tobacco smoke outside the home improved among all income groups but it was decreased further in the highest income group (family income >\$60,000 per year). The law also had varying effects among different educational groups, with a higher increase in the odds of having a no-smoking policy at home following the implementation of the smoking ban among those with some college education. When the results were stratified by rural vs non-rural place of residence, the effects of 2009 Wisconsin Act 12 were similar in both areas (not shown).

Table 4. Unadjusted Odds Ratios Comparing Smoking Behaviors and Exposure to Tobacco Smoke After vs Before the Enactment of Wisconsin Act 12 Stratified by Age, Family Income, and Educational Level, Survey of the Health of Wisconsin, 2008-2010.^a

	21–40-Year-Old Age Group		41–60-Year-Old Age Group		61–74-Year-Old Age Group	
	Total n	Odds Ratio (95% CI)	Total n	Odds Ratio (95% CI)	Total n	Odds Ratio (95% CI)
Being current smoker	242	1.68 (0.82-3.43)	461	0.88 (0.54-1.42)	203	0.94 (0.34-2.59)
Participants being exposed to smoke outside home	224	0.30 (0.18-0.51)	419	0.34 (0.21-0.55)	183	0.26 (0.13-0.54)
Participants being exposed to smoke at work	230	0.89 (0.47-1.71)	432	0.54 (0.28-1.02)	187	0.26 (0.06-1.13)
Participants being exposed to smoke at home	240	0.84 (0.28-2.51)	455	0.33 (0.15-0.75)	199	0.18 (0.05-0.75)
Smokers who want to completely quit smoking	55	0.78 (0.34-1.79)	87	0.51 (0.16-1.61)	18	0.52 (0.10-2.58)
Smokers who considered quitting within next 6 months	52	4.38 (0.54-35.8)	82	1.15 (0.68-2.0)	17	0.20 (0.02-1.84)
Participants having a strict ban in the home	290	1.15 (0.54-2.44)	495	1.62 (1.06-2.47)	208	1.58 (0.80-3.15)
	Family Income <\$30,000 Per Year		Family Income \$30,000-\$59,999 Per Year		Family Income ≥\$60,000 Per Year	
	Total n	Odds Ratio (95% CI)	Total n	Odds Ratio (95% CI)	Total n	Odds Ratio (95% CI)
Being current smoker	200	1.03 (0.53-1.99)	287	1.35 (0.79-2.32)	385	1.03 (0.59-1.78)
Participants being exposed to smoke outside home	172	0.52 (0.30-0.88)	262	0.31 (0.17-0.58)	361	0.26 (0.17-0.39)
Participants being exposed to smoke at work	181	1.14 (0.64-2.01)	273	0.38 (0.17-0.82)	365	0.52 (0.26-1.04)
Participants being exposed to smoke at home	192	0.35 (0.10-1.18)	285	1.07 (0.52-2.19)	384	0.17 (0.07-0.45)
Smokers who want to completely quit smoking	54	0.58 (0.18-1.86)	51	0.48 (0.16-1.46)	47	0.76 (0.35-1.66)
Smokers who considered quitting within next 6 months	52	0.38 (0.09-1.56)	46	1.01 (0.50-2.02)	46	3.03 (1.14-8.05)
Participants having a strict ban in the home	238	1.77 (0.93-3.36)	313	0.79 (0.45-1.38)	405	1.77 (1.02-3.07)
	High School Education or Lower		Some College Education or Higher			
	Total n	Odds Ratio (95% CI)	Total n	Odds Ratio (95% CI)		
Being current smoker	272	0.90 (0.50-1.63)	633	1.19 (0.78-1.81)		
Participants being exposed to smoke outside home	232	0.29 (0.16-0.53)	593	0.32 (0.22-0.47)		
Participants being exposed to smoke at work	250	0.53 (0.27-1.04)	598	0.64 (0.36-1.13)		
Participants being exposed to smoke at home	259	0.52 (0.26-1.02)	634	0.32 (0.17-0.63)		
Smokers who want to completely quit smoking	75	0.31 (0.07-1.45)	85	1.10 (0.47-2.61)		
Smokers who considered quitting within next 6 months	72	0.51 (0.29-0.91)	79	3.78 (1.33-10.80)		
Participants having a strict ban in the home	317	1.11 (0.61-2.03)	676	1.63 (1.11-2.41)		

^aParticipants that were exposed to a local smoking ban before 2010 were excluded. Abbreviation = CI, confidence interval.

DISCUSSION

The implementation of smoke-free legislation in Wisconsin was associated with a statistically significant decline in reported exposure to tobacco smoke outside the home, inside the home, and at work among SHOW participants. These results are consistent with those of previous studies on the effects of smoke-free legislation in parts of Europe, Canada, and the United States.¹ For example, a phone interview study conducted in Ontario, Canada that evaluated whether smoking bans affect rates of secondhand smoke exposure also found that smoke-free legislation was associated with decreased exposure in public places, the home, and in the workplaces of its survey participants.¹³

It is noteworthy that our results showed that smoke-free legislation in Wisconsin was associated with a decrease in sec-

ondhand smoke exposure not only in public places, but also in the home; it also was associated with an increase in prevalence of no-smoking policies in the households of Wisconsin residents. According to our results, only 20.4% of households in Wisconsin did not have a strict no-smoking policy after 2009 Wisconsin Act 12 went into effect. This number is much lower than the 1999 estimate provided by the Centers for Disease Control and Prevention, which showed that 55.3% of Wisconsin households in 1999 did not have smoking policies.¹⁴ Most previous studies on the effects of smoke-free legislation on secondhand smoke exposure in the home did not find the association seen in our results. A study conducted in Hong Kong before and after the implementation of smoke-free legislation in 2007 found that such legislation increased smoke exposure in the home.¹⁵ A review by Callinan et al

found that smoke-free legislation generally was not associated with a decrease in secondhand smoke exposure in the home.¹ Similar results to this review article also were found in a study conducted in Scotland in 2006.¹⁶ A telephone interview study conducted in Ireland after implementation of its smoke-free legislation in 2004 found that 71% of Irish smokers reported that the legislation did not affect their smoking behaviors in the home, 22% reported that it had caused them to place stronger home smoking restrictions, and 6% reported smoking more in their homes.¹⁷ In contrast, a study conducted in Scotland before and after the implementation of smoke-free legislation found that the legislation had increased home smoking restrictions.⁴ Further research is needed to reconcile these different findings on the effects of smoke-free legislation on smoking behaviors in the household.

With regard to changing the smoking behaviors of Wisconsin residents, in the short time since its implementation, 2009 Wisconsin Act 12 did not appear to be associated with a reduction in smoking prevalence or in the number of current smokers who wanted to completely quit or were considering quitting. Furthermore, we only found a slight, non-statistically significant reduction in the mean number of cigarettes smoked among current smokers in our study sample. Previous studies reporting on these outcomes have not been entirely consistent. For example, a study conducted in the town of Bury, England in 2007 found that England's smoke-free legislation did not affect smoking prevalence but did decrease the number of cigarettes smoked among current smokers.¹⁸ Other studies conducted in Canada, Italy, and the United States found that smoke-free legislation significantly decreased smoking prevalence by as little as 1.9% and as much as 14.4%.^{2,5-7,19} It is important to note that some of these studies had much larger sample sizes. The number of current smokers in the SHOW data so far was only 167, a number that limits the statistical power of the study when it comes to analyzing the effects of the law on smoking prevalence and on the behaviors of current smokers. It is also possible that more time is required for this kind of legislation to have an effect on active smoking behaviors. As the sample size of the SHOW data and the time since the new legislation increases over the coming years it will be possible to analyze the effects of 2009 Wisconsin Act 12 on smoking behaviors with greater statistical power.

Our results also demonstrate that 2009 Wisconsin Act 12 generally had a larger impact on exposure to smoke among Wisconsin residents who were older, wealthier, and more educated. When it comes to exposure to smoke outside the home, at work, and at home, the 61–74-year-old age group had the largest reduction after the implementation of 2009 Wisconsin

Act 12. Participants with a family income greater than \$60,000 per year also reported the largest reduction in exposure to smoke outside and inside the home, while the middle income group (\$30,000–\$59,999 per year) reported the largest reduction in exposure to smoke at work. The reduction in exposure to smoke outside the home and at work was about the same in both education groups but a larger reduction was seen in exposure to smoke at home in the group with a college education or higher. Those in the higher education group were also more likely to have a strict no-smoking ban in the home. A study conducted in the United States, Canada, the United Kingdom, and Australia regarding socioeconomic and country variations in smokers' knowledge found that higher education and income were associated with higher awareness of the negative effects of smoking.¹⁹ The authors of this study explained this association by suggesting that such differences might exist because those who are wealthier and more educated have a wider knowledge of and access to sources of information. This can therefore make these groups more capable of reaping the benefits of laws such as 2009 Wisconsin Act 12 earlier and may explain the variation seen in our results among different income and educational groups. However, further research is needed to understand why differences based on socioeconomic variation were found in the current study.

CONCLUSION

The main findings of this study are that smoke-free legislation in Wisconsin increased the number of participants who reported having strict no-smoking policies in their households and decreased reported exposure to tobacco smoke outside the home, inside the home, and at work. If such results are maintained in the future, it is likely that smoke-free legislation can play a significant role in reducing the incidence of tobacco-related illnesses and in improving overall health outcomes.

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