Minnesota's Comprehensive Statewide Smokefree Law
Short-Term Effects on Young Adults

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Background: Young adults have the highest rate of smoking among any age group.

Purpose: The purpose of this study is to assess the short-term effects of Minnesota's comprehensive statewide smokefree law on young adult smoking perceptions and behavior.

Methods: Telephone surveys were conducted before and up to 18 months after Minnesota's statewide smokefree law went into effect on October 1, 2007 (data analyzed 2010–2011). Participants included young adults from a population-based cohort in Minnesota ($n=1458$) and from five other upper Midwest states that serve as a comparison ($n=248$). Differences in perceptions and smoking behavior were examined between Minnesota participants who lived with and without a local smokefree law prior to Minnesota's statewide law, and participants who lived in the comparison states.

Results: The majority of youth in Minnesota were aware of the smoking restrictions in restaurants and bars following the law. After implementation of the law, Minnesota participants who previously lived without a local law (versus comparison) were more likely to perceive fewer adult and peer smokers and less likely to report leaving social events early because it was too smoky. No changes in smoking behaviors were observed before and after the law. Minnesota participants, however, who lived without a prior law (versus participants with a prior law) were more likely to attribute a quit attempt after the law to smoking restrictions in restaurant and bars.

Conclusions: Results suggest that Minnesota's law has changed perceptions of the tobacco environment. Longer-term follow-up may be needed to observe changes in smoking behavior.
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Introduction

Young adults have the highest rates of tobacco use among any age group.[1] In 2010, 34% of young adults in the U.S. reported past-month smoking, compared to 23% among those aged ≥25. Youth are initiating and progressing to regular smoking after high school. A recent study, for example, found that 25% of young people initiated smoking between the ages of 18 and 21 years.[2] Young adult smokers also report greater smoking intensity than adolescents. Eleven percent of young adults aged 25–26 years report smoking a half-pack of cigarettes or more per day compared to 5% of those aged 18 years.[3] Smoking during young adulthood may differ from adolescence because young adulthood is a time of transition to independent living associated with new sources of stress, as well as to new settings where smoking may be acceptable.

Research[4–8] suggests that smoking restrictions in public places may reduce smoking rates and increase cessation. One study[9] estimated that smokefree laws may reduce smoking prevalence and consumption rates across the entire population by 10%. Little is known, however, about the effects of smokefree laws on various demographic groups, particularly young adults. Young adults may be more likely to be affected by smokefree laws that include restaurants and bars because they are more likely to work in and frequent these establishments than older adults.[10]

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Although the majority of studies have focused on the effects of smoking restrictions on adolescents and adults, a few studies suggest that smokefree laws also may have a positive public health effect on young adults. A recent study,[11] for example, showed that young adults perceived fewer opportunities to smoke after a statewide smokefree law was enacted. Using data from the Harvard College Alcohol Study, Chaloupka and Wechsler[12] found that laws restricting smoking in restaurants were associated with lower smoking rates among college students. They also found that smoking restrictions in public places were associated with lower cigarette consumption among smokers. Similarly, data from a nationally representative sample showed that smoking restrictions in private worksites and other public places were associated with a decrease in moderate smoking uptake among young adults.[8]

The goal of the present study is to add to the limited literature on the effects of comprehensive smokefree laws on young adults. Earlier studies examining effects of smokefree laws on young adults focused on worksite policies, many of which did not include restaurants and bars. In addition, few studies have focused on the effects of *statewide* smokefree policies. The current study addresses these limitations by examining the effect of Minnesota's statewide smokefree law (effective October 2007) on smoking behavior, as well as smoking-related attitudes and beliefs that are important for understanding how smokefree laws may be working to change behavior.

Methods

Minnesota Adolescent Community Cohort Study Design

Data were analyzed from the population-based Minnesota Adolescent Community Cohort (MACC) cohort study that began in 2000. In 2000, participants were aged 12–16 years and included youth living in Minnesota (n=3636) as well as those (n=605) from five other upper Midwest states (North Dakota, South Dakota, Missouri, Kansas, and Michigan) that were demographically and geographically similar to Minnesota and serve as a comparison. The comparison states were included to control for secular trends in smoking over time. An additional 584 participants aged 12 years from Minnesota were recruited in 2001, for a total sample of 4825.

The state of Minnesota was divided into 129 geographic areas, and 60 were selected randomly. A combination of probability and quota sampling methods was used to recruit 60 participants from each area. Recruitment was conducted via telephone using modified random-digit-dial (RDD) sampling. Households with at least one teenager between the ages of 12 and 16 were contacted, and respondents were selected at random from open age quota cells (response rate, 58.5%).

Participants consented to complete telephone interviews (lasting 10–20 minutes) about their smoking-related attitudes and behavior. Interviews were structured so that spoken responses would not be revealing to anyone overhearing the respondents. The University of Minnesota IRB approved the study. Additional details about the study can be found elsewhere.[13]

Present Study

Minnesota's statewide smokefree law went into effect on October 1, 2007. The present study includes three rounds of data collected prior to Minnesota's law (12–18 months pre-law: April to September 2006; 6–12 months pre-law: October 2006 to March 2007; 0–6 months pre-law: April to September 2007) and two rounds of data collected after the law went into effect (0–6 months post-law: October 2007 to March 2008; 12–18 months post-law: October 2008 to March 2009). Data were not collected 6–12 months after the law was implemented. Analyses were conducted in 2010 and 2011. The mean age of the participants at baseline (12–18 months pre-law) was 19.3 (SD=1.7). Participants were excluded if (1) they did not participate in all five rounds of data collection; (2) their exposure to a smokefree law changed during the pre-intervention time points; or (3) they no longer lived in Minnesota or one of the comparison states. The final sample for the study included 1458 participants from Minnesota (1111 without a local smokefree law and 347 with a local smokefree law prior to the statewide law) and 248 participants from the comparison states (total=1802). None of the comparison states implemented statewide smokefree laws during the study period. For all data collection rounds (except 12–18 months post-law), participants aged <18 years received $10 per survey and those aged ≥18 years received $15. At 12–18 months post-law, all participants received $20 for completing the survey.

Measures

Five categories of outcome variables were measured.

1. Awareness of smokefree laws in restaurants and bars. Participants indicated whether the law in their community prohibited adults from smoking in restaurants (*yes/no*) and bars/clubs (*yes/no*).

2. Perceptions of the number of adult and peer smokers. Participants indicated whether they thought the number of adults who smoke had increased, decreased, or stayed about the same compared to 6 months ago. A similar question was asked about peers. Each variable was coded as a dichotomous variable for analysis purposes, in which 1 denoted decreased and 0 denoted all other response options.

3. Exposure to smoking. Participants were asked three questions regarding exposure to smoking (response options: *yes/no*): (1) *In the past 6 months have you ever left early from a party, social event, club, bar, or hanging out with friends because it was too smoky?* (2) *Are adult guests allowed to smoke inside your home?* and (3) *Are adults who live with you allowed to smoke inside your home?* Questions 2 and 3 were assessed only among those who lived with their parents and were combined into a single item to indicate whether adults and guests were prohibited from smoking in the home, with 1 representing that neither were allowed to smoke in the home and 0 representing that either or both adults and guests were allowed to smoke in the home.

4. Prevalence and quantity of smoking. Past 30-day smoking (*yes/no*); the mean number of days smoked in the past 30 days

(among smokers); and the mean number of cigarettes smoked in the past 30 days (among smokers) were assessed.

5. Quit attempt due to smoking restrictions in restaurants and bars. Participants who indicated a quit attempt after the statewide law went into effect were asked whether smoking restrictions in restaurants and bars were a reason they most recently attempted to quit smoking (*yes/no*).

Additional variables included demographic characteristics and whether participants lived with a prior local smokefree law.

Demographic characteristics. Gender, race/ethnicity, and age were assessed. Race/ethnicity was coded as a dichotomous variable (1=non-Hispanic white, 0=other race/ethnicity) because of the limited racial and ethnic diversity in the cohort. Age was measured as a continuous variable based on respondents' date of birth and date of survey completion at baseline. Current educational enrollment and highest degree obtained at age 19 were used to assess education level: (1) not enrolled in college; (2) enrolled in a 2-year college or obtained a 2-year degree; and (3) enrolled in a 4-year college.

Prior comprehensive local smokefree law. Existence of a prior local law restricting smoking in restaurants and bars was coded for each participant based on their geocoded address at each round. Data on smokefree laws were obtained from the American Nonsmokers' Rights (ANR) Foundation (www.no-smoke.org).

Data Analytic Strategy

Three groups were created for analysis purposes: (1) Minnesota participants living with a local smokefree law prior to the statewide law (Prior Law group); (2) Minnesota participants living without a local smokefree law prior to the statewide law (No Prior Law group); and (3) participants living in the comparison states (Comparison group). Chi-square tests and ANOVAs were used to compare sample characteristics among the three study groups at baseline. The effect of the law was assessed using general or generalized linear models, accounting for the repeated measurements within individuals and clustering by geographic area. Models included main effects for time period (pre-law versus post-law) and group, as well as the interaction between time period X group. Pairwise comparisons were conducted to assess differences in changes on these outcomes before and after the law by study group (No Prior Law versus Comparison, Prior Law versus Comparison, and No Prior Law versus Prior Law). Days smoked and the number of cigarettes smoked in the past 30 days were assessed only among participants who reported smoking in all pre-law data-collection rounds. All models controlled for demographic characteristics, including age, gender, race, and education, and were conducted in SAS, version 9.2.

Results

Demographic characteristics and smoking behaviors at baseline (12–18 months pre-law) for the three study groups are shown in Table 1. The three study groups differed on age, $F(2, 1703)=9.90$, $p<0.0001$; race, $\chi^2(2)=47.21$, $p<0.0001$; and education, $\chi^2(4)=35.19$, $p<0.0001$. No differences were observed among the three groups on gender or baseline smoking including past 30-day smoking prevalence; mean days smoked in the past 30 days (among smokers); and mean cigarettes smoked in the past 30 days (among smokers). Comparisons of the three study groups on the outcome variables are shown in Table 2.

Table 1. Baseline[a] demographic characteristics and smoking behaviors by study group, % or M (SD)

Characteristics	Minnesota		Comparison states (*n*=248)
	No prior law (*n*=1111)	Prior law (*n*=347)	
DEMOGRAPHICS			
Age (years)*	19.2 (1.7)	19.4 (1.7)	19.8 (1.4)
Gender			
Male	47.8	50.7	50.8
Female	52.2	49.3	49.2
Race*			
White	93.3	81.0	91.9
Other race	6.8	19.0	8.1
Education at age 19 years*			
Not in college	33.8	24.4	31.2
2-year college	11.5	6.1	4.1
4-year college	54.7	69.5	64.8
SMOKING BEHAVIOR			
Past 30-day smoking			
Yes	23.5	21.6	23.0
No	76.5	78.4	77.0
Days smoked[b]	15.4 (12.8)	16.9 (12.4)	14.0 (12.7)
Cigarettes smoked[b]	6.3 (7.1)	6.9 (7.1)	6.2 (7.6)

[a]12–18 months pre-law
[b]In past 30 days, included only smokers
*Difference between study groups significant at $p<0.05$

Smoking-Related Perceptions

The proportion of Minnesota participants who were aware of smoking restrictions in restaurants and bars/clubs increased in both the No Prior Law and the Prior Law groups after the law went into effect. The change in awareness was greater, however, among those in the No Prior Law group. For restaurants, the increase in awareness for the No Prior Law group was 9.11 times the increase observed among the Prior Law group. For bars, the increase for the No Prior Law groups was 12-fold of the corresponding increase among the Prior Law group.

After Minnesota's statewide law went into effect, the No Prior Law group was more likely than both of the

Table 2. Comparisons of the three study groups

	Percentages		AOR (95% CI)[a]		
	Pre-law	Post-law	No prior law vs comparison	Prior law vs comparison	No prior law vs prior law
SMOKING-RELATED PERCEPTIONS					
Awareness of statewide restaurant law	—	—	—	—	**9.11 (6.84, 12.11)**
MN no prior law	14.9	78.7	—	—	—
MN prior law	54.3	75.4	—	—	—
Awareness of statewide bar law			—	—	**11.87 (8.86, 15.92)**
MN no prior law	7.7	68.2	—	—	—
MN prior law	37.2	59.2	—	—	—
Perceived fewer adults smokers	—	—	**1.64 (1.19, 2.28)**	1.25 (0.82, 1.90)	**1.36 (1.02, 1.80)**
MN no prior law	—	16.3	—	—	—
MN prior law	—	12.8	—	—	—
Comparison	—	11.3	—	—	—
Perceived fewer peer smokers	—	—	**2.40 (1.41, 4.10)**	1.56 (0.92, 2.65)	**1.45 (1.02, 2.06)**
MN no prior law	—	10.7	—	—	—
MN prior law	—	7.9	—	—	—
Comparison	—	5.6	—	—	—
EXPOSURE TO SMOKING					
Left social events early due to smoking	—	—	**0.60 (0.45, 0.78)**	0.73 (0.53, 1.03)	0.81 (0.62, 1.05)
MN no prior law	30.6	23.6	—	—	—
MN prior law	25.9	22.9	—	—	—
Comparison	33.3	36.5	—	—	—
Smoking not allowed at home[b]	—	—	1.44 (0.81, 2.58)	1.17 (0.60, 2.28)	1.22 (0.76, 1.95)
MN no prior law	85.3	85.9	—	—	—
MN prior law	88.0	86.0	—	—	—
Comparison	88.6	85.5	—	—	—
SMOKING BEHAVIOR					
Past 30-day smoking	—	—	1.07 (0.78, 1.46)	1.11 (0.77, 1.61)	0.96 (0.73, 1.26)
MN no prior law	23.4	23.3	—	—	—
MN prior law	21.6	22.1	—	—	—
Comparison	22.4	21.3	—	—	—
Mean days smoked in past 30 days[c]	—	—	0.79 (−2.76, 4.33)	0.83 (−3.33, 5.00)	0.08 (−3.17, 3.33)
MN no prior law	19.62	18.88	—	—	—
MN prior law	20.84	20.09	—	—	—
Comparison	21.32	19.04	—	—	—
Mean cigarettes smoked in past 30 days[c]	—	—	0.53 (−1.88, 2.95)	1.54 (−1.43, 4.51)	−0.88 (−2.94, 1.19)
MN no prior law	7.53	7.20	—	—	—
MN prior law	7.93	8.27	—	—	—

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Table 2. Comparisons of the three study groups *(continued)*

	Percentages		AOR (95% CI)[a]		
	Pre-law	Post-law	No prior law vs comparison	Prior law vs comparison	No prior law vs prior law
Comparison	8.94	8.16	—	—	—
Restrictions reason for quitting[d]	—	—	1.09 (0.40, 2.95)	NA[e]	**3.26 (1.20, 8.89)**
MN no prior law	—	40.0	—	—	—
MN prior law	—	15.8	—	—	—
Comparison	—	36.4	—	—	—

Note: Boldface indicates significance.
[a]AOR is adjusted for age, gender, race, and education at age 19 years.
[b]Only those living with parents
[c]Only those who reported smoking in the past 30 days during all three pre-law data points (n=153 in No Prior Law, n=49 in Prior Law, n=37 in Comparison groups).
[d]Only those who attempted to quit
[e]Not available; model did not converge
MN, Minnesota

other study groups (i.e., Prior Law and Comparison) to report that the number of adult and peer smokers decreased compared to 6 months ago. Participants in the No Prior Law group were 1.36 times more likely to report that the number of adult smokers had decreased than the Prior Law group and 1.64 times more likely than the Comparison group. Participants in the No Prior Law group were 1.45 times more likely to report that the number of peer smokers had decreased than the Prior Law group and 2.40 times more likely than the Comparison group.

Exposure to Smoking

After the statewide law, the No Prior Law group was less likely than the Comparison group to report leaving social events early because it was too smoky. No differences were found between the study groups on the proportion of participants who reported home smoking bans before and after the statewide law was implemented.

Prevalence and Quantity of Smoking

No differences were observed between the study groups on smoking behavior, including the prevalence of past 30-day smoking; mean number of days smoked in the past 30 days (among smokers); and mean cigarettes smoked in the past 30 days (among smokers).

Quit Attempt Due to Smoking Restrictions in Restaurants and Bars

Forty percent of the No Prior Law group reported that a quit attempt after Minnesota's statewide law was due to smoking restrictions in restaurants and bars, which was 3.26 times that observed in the Prior Law group.

Discussion

The purpose of the present study was to assess the short-term effects of Minnesota's statewide smokefree law on young adult smoking perceptions and behavior. The majority of young adults in Minnesota were aware of the smoking restrictions in bars and restaurants after the statewide law went into effect. A greater proportion of young adults, however, reported being aware of smoking restrictions in restaurants than in bars. These results suggest that it may be important to emphasize the inclusion of bars when comprehensive statewide smokefree laws are implemented.

Greater increases in awareness of smokefree laws were found among participants in the No Prior Law compared to the Prior Law group. However, awareness increased among the Prior Law group, even though the law did not change in these communities. It is likely that media coverage increased around the time the statewide law was implemented and may have resulted in increased awareness among all youth across the state.

Minnesota's law also had an effect on young adults' perceptions of the smoking environment. Participants in the No Prior Law group were more likely to report that the number of adult and peer smokers had decreased in the past 6 months after the statewide law was implemented than participants in the Prior Law and Comparison groups. These findings suggest that Minnesota's law may be affecting social norms around smoking. The results are consistent with a previous study showing that adolescents living in towns with strong smoking restrictions perceived lower smoking prevalence among adults.[14] Perceptions of smoking prevalence has been

associated with smoking behavior in previous studies[15] and may explain, in part, how smokefree laws are working to reduce smoking rates.

After the statewide law, participants in both the Minnesota groups were less likely than comparison participants to report leaving social events early because it was too smoky. Social events included hanging out in bars, but also a number of other events that would not necessarily be regulated by Minnesota's statewide law (i.e., parties, hanging out with friends). It is possible that statewide smokefree policies reduce smoking in locations not directly regulated by statewide policies. Smokefree policies generally are viewed favorably by the public once they are implemented[16] and may increase the number of smokefree policies in other locations, such as private homes. No differences, however, were found between the study groups on the proportion of participants who reported home smoking bans. A high proportion of participants, however, reported having home smoking bans when the statewide law was implemented. Further research is needed to examine the effects of smokefree laws on smoking restrictions in other locations.

Despite the effects of the law on smoking-related perceptions, results showed no effect of the law on smoking behavior. It is possible that longer follow-up may be needed to observe such changes. Previous work by Hahn[5] suggests that follow-up time is a critical factor in examining effects of smokefree laws on smoking behavior. Hahn[6] found, for example, that individuals who lived with an established law (36 months post) were three times more likely to be former smokers than those with a relatively recent law (6–8 months post). Although results indicate no change in frequency or quantity of smoking, Minnesota smokers who lived without a prior local law were more likely than those who lived with a prior law to have made a quit attempt because of smoking restrictions in restaurants and bars. Thus, changes in smoking behavior associated with Minnesota's statewide smokefree law may be observed with greater follow-up time.

The current study has limitations that should be considered when interpreting the results. First, the present study assesses only the effects of Minnesota's statewide smokefree law and may not generalize to other states. Furthermore, the sample was primarily white and may not generalize to states with a more diverse racial and ethnic composition. Second, follow-up was limited to 12–18 months, and longer follow-up may be needed to observe changes in smoking behavior. Although all smoking behavior was self-reported, this has been shown to have high sensitivity and specificity, and the concern about under-reporting is minimized because most participants were over the legal age to smoke.[17] Another potential limitation is that although the Minnesota cohort was designed to be representative of youth in Minnesota at its inception, the cohort may no longer be representative because of attrition. However, a large and diverse sample of young adults was drawn from a population-based cohort, and a high response rate was maintained over time. Finally, a smaller cohort of youth was followed from the comparison states (than in Minnesota) and may have reduced the power of the study. A visual examination of the outcome variables, however, did not suggest that any substantial findings were not detected because of the sample size.

The present study also has its strengths. First, a comparison cohort was included, which allowed us to control for secular trends in smoking. Second, unlike many previous studies, the cohort is a population-based sample that includes young adults who are enrolled in college and those who are not, allowing us to assess the effects of Minnesota's statewide law on the entire young adult population who may be affected by the law.

Conclusion

Minnesota's statewide smokefree law was associated with perceived reductions in the number of adult and peer smokers. Those exposed to the law were also less likely to report leaving social events early because of smoking after the law went into effect compared to participants in the comparison cohort. Although no effect of the law was found on smoking behavior, Minnesota participants with no prior law were more likely to attribute a recent quit attempt to smoking restrictions in restaurants and bars compared with those exposed to a prior law.

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