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The relationship between local clean indoor air policies and smoking initiation in Minnesota youth

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Abstract

Background—While clean indoor air (CIA) policies are intended to reduce exposure to secondhand smoke in the workplace, restrictions in public workplaces have the potential to discourage youth smoking. There is growing evidence from cross-sectional and ecologic studies, but limited evidence from longitudinal studies that this is so.

Objective—To evaluate the association between local clean indoor air (CIA) policies and smoking initiation among Minnesota youth over time.

Design, setting, and subjects—A cohort of 4233 Minnesota youths, ages 11 to 16 at baseline, was interviewed via telephone for six years (2000 – 2006). Individual, family, and community level variables were collected from participants every six months. A generalized linear mixed model was used to assess the relationship between smoking initiation and CIA policies over time. The analysis was controlled for potential confounders at the individual- and community-level.

Results—Youth living in an area without a CIA policy were 8% more likely to initiate smoking (OR=1.08 CI: 1.00 – 1.16) compared to youth living in an area with a local CIA policy, after adjustment for multilevel covariates.

Conclusion—Local CIA policies accounted for a small, but significant, reduction in youth smoking initiation among Minnesota youth in this cohort. This study provides additional support for use of CIA policies to prevent exposure to secondhand smoke and smoking initiation in youth.

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What this paper adds

- This evaluation provides support for the association between the enactment of local CIA policies and a reduction in youth smoking initiation.
- This multilevel analysis accounts for individual- and community-level factors associated with youth smoking, and the prospective design provides additional assurance of the temporal association.

INTRODUCTION

Improving our knowledge of modifiable factors that can influence youth smoking has great public health importance, given that an estimated 80% of smokers in the United States start smoking before the age of 18.[2] As a result, prevention or reduction of smoking early in life is the most efficient means of reducing the morbidity and mortality associated with smoking, and may be one of the most efficacious and appropriate public health interventions for youth. [3]

Youth are influenced by factors at multiple levels that encourage or discourage smoking. At the individual level, a number of modifiable interpersonal factors are known to contribute to youth smoking, including parental and close peer smoking. [4–6] At the community level, bans on smoking in homes, workplaces, and restaurants perhaps by making smoking less acceptable have been associated with a reduction in youth smoking. [7–12] In particular, initial studies have suggested that smoking restrictions in public workplaces may significantly reduce youth smoking prevalence and progression. The importance of individual and community-level factors in influencing youth smoking underscores the importance of using multilevel designs to evaluate youth smoking behaviours. [13]

Policies to restrict smoking in workplaces are generally referred to as clean indoor air (CIA) policies. Such policies are established to protect workers from exposure to environmental tobacco smoke (ETS) on the job, [14] but also may create an environment that discourages youth smoking. Therefore, CIA policies that apply to public workplaces may send a message to youth that smoking is not socially acceptable. [15] Further, these restrictions decrease opportunities for the social exchange of cigarettes, and decrease the number of locations where youth can smoke in public, as noted by Alesci and others. [11,16]

Minnesota is a state in the midwestern United States that adopted a state-level CIA policy designating smoking areas for workplaces in 1975, the first in the U.S. Starting in 2000, local cities and counties enacted 100% smokefree local CIA policies that applied to worksites, many that included bars and/or restaurants. By 2007, Minnesota had established 18 local CIA policies; on October 1, 2007 a comprehensive CIA policy for the state was enacted.

Evidence for this relationship between CIA policies and youth smoking behaviour is limited, but growing. Much existing evidence comes from economic analyses in the U.S. where youth cigarette consumption has reduced in response to local CIA policies, [17] and that CIA policies in all workplaces were associated with lower youth smoking prevalence.[18] Further, more extensive restrictions on smoking are associated with reduced odds of youth smoking initiation and regular use.[8] While such cross-sectional studies support the hypothesis that CIA policies are associated with a decrease in youth smoking prevalence, it is impossible to determine whether these policies caused the regulation, or whether communities with lower youth smoking are more likely to adopt a CIA policy. To date, a single peer-reviewed study completed by Siegel et al. found a protective effect of CIA policies on youth smoking progression over a two-year period. [19] Additional longitudinal studies are needed to confirm the strength and

temporal relationship between CIA policy and youth smoking behaviour. The paper assesses the influence of CIA policies on youth smoking initiation using a multilevel analysis of longitudinal data on a cohort of youth living in Minnesota.

METHODS

Sample

Data were drawn from a large, population based cohort study of Minnesota youth - the Minnesota Adolescent Community Cohort (MACC) Study. The MACC study collected data on a number of individual-, family-, community-, and state-level factors that relate to youth tobacco use.

This study used a unique sampling frame that divided Minnesota into group-level units based on geographical and political (GPU) boundaries thought to reflect local tobacco control environments. The state was divided into 129 GPUs, and 60 were sampled at random from three strata – region of the state, ethnic minority population, and population density.

From these 60 GPUs, 60 teenagers within each GPU were recruited for participation. Youth aged 12 to 16 were interviewed over the phone every six months, starting in fall 2000. The original cohort of Minnesota participants (n=3,636), as well as an additional cohort of 12-year old participants recruited one year later (n=597) were followed prospectively for seven years, to date. The study period ran from 2000 to 2006, which represented 11 phone surveys (survey 1 through 12; survey 7 is missing due to a gap in funding). A combination of incentives, multiple callbacks, and extensive tracking and tracing procedures has resulted in a retention rate of 77.9% at the end of 6 years. Participants that did not complete a survey were treated as missing for that survey, but were retained in the sample.

Measures

The primary outcome variable for this analysis was smoking initiation. Initiation to smoking was defined as self-reported ever smoking at least one whole cigarette (yes/no). The primary explanatory variable of interest was CIA policy status. This variable was defined as any CIA policy enacted at either a city- or county-level that restricted smoking beyond the state-level CIA policy in effect at the time. These policies, for the most part, restricted or banned smoking in bars and/or restaurants. We obtained data on all local Minnesota CIA policies during the study period; nine cities or counties established local CIA policies, starting in 2004. We dichotomized each CIA community in the MACC study as having either a local CIA policy that restricts smoking in bars and/or restaurants or no CIA policy, where smoking areas are designated or not restricted. Each study participant was assigned CIA policy status based on city of residence for that survey.

Multilevel covariates

Variables included in the analysis were factors thought to contribute to youth smoking behaviour at either the individual- or community-levels. At the individual level, covariates included both time-varying and time-invariant variables. Time-varying variables included the number of four closest friends who smoke (0 through 4), current indoor household smoking ban (yes or no), and age (in years). Time-invariant covariates included birth cohort (age in the year 2000: 11 through 16), gender, race/ethnicity (White, Black, American Indian, Asian, Hispanic/Latino, and other), maternal or paternal smoking status at baseline (yes or no), and region of residence at baseline (rural, suburban, or urban).

Community-level covariates were derived from U.S. Census 2000 data.[20] Data were assigned to study participants based on the GPU of residence at baseline. Covariates included percentage

of the population aged 18 or older, percentage of the population with a college degree or higher, percentage of the region defined as rural, percentage of the population reporting White race, and median household income.

Data analysis

Individuals within areas may be correlated, potentially due to a number of factors, including shared experiences. To account for this lack of independence, a generalized linear mixed model was used to account for both population characteristics shared by all subjects (fixed effects) and subject-specific effects that are unique to a particular individual (random effects). Due to the nesting, GPU was used to account for any intra-class correlation (ICC). GPU was used instead of city to account for general effects at the community-level for consistency with the study design, and assumes that the effect of clustering by city or GPU is quite small. The analysis was performed using PROC GLIMMIX in SAS version 9.1.3. [21]

RESULTS

Of the MACC cohort, 4,233 participants from the state of Minnesota were included in the analysis. Given the six years of follow-up in this study, age, birth cohort and period effects were evaluated to determine appropriate model specification. Age was a highly statistically significant predictor of smoking behaviour, consistent with the youth smoking literature.[2] Birth cohort was also significantly associated with smoking initiation, as a younger age at baseline was a significant protective factor against smoking initiation. An age by birth cohort interaction was evaluated and although statistically significant ($p<0.01$), visual inspection of smoking initiation over time by birth cohort showed only one age group (baseline age of 14) had a meaningful change in slope relative to the other birth cohorts (data not shown). Due to the strong age effect, and the relatively minor interaction with birth cohort shown in the unadjusted plot, a simpler model without an age by birth cohort interaction was preferred to reduce model complexity.

A description of the demographic characteristics of the sample at the individual- and community-level is provided in Table 1, both overall and stratified by CIA policy status. At the time of the most recent assessment (survey 12), 1,028 participants lived in an area with a local CIA policy. Overall, the participants living in an area with a CIA policy did not significantly differ in demographic characteristics from participants in areas without a CIA policy, with the exception of race/ethnicity and region of the state. The proportion of youth from each birth cohort was roughly equivalent comparing youth in the policy to those without a CIA policy. The distribution of gender was evenly balanced, with approximately 51% females in each sample. Race/ethnicity were statistically significantly different by policy status, with a higher proportion of White youth in the no policy sample (89% vs. 72%), more Blacks in the policy sample (15% vs. 2%), while other race/ethnic groups had similar proportions in both samples. Approximately 25% of both samples had a mother who was a smoker at baseline, and 25% had a father who was a smoker at baseline. By the most recent survey, most participants reported a current smoking ban in the home (80% in the policy participants, 78% in the no policy participants). More of the participants in CIA policy communities lived in urban areas (47%) or suburban areas (43%); most of the participants without CIA policies lived in rural areas (64%), some suburban areas (33%), and a few urban areas (3%). At baseline, less than 15% of participants had initiated smoking, and no communities in the sample had established a CIA policy; at the most recent survey, 46% of participants had ever smoked at least a whole cigarette.

At the community-level, the cities with a CIA policy had a slightly higher percentage of college graduates (35% vs. 23%), were significantly less rural (6% vs. 43%), with a lower percentage of White residents (73% vs. 93%), and a slightly higher median household income (~$51,000

vs. ~$48,000), compared to communities without a CIA policy, as reported in the 2000 U.S. Census. All mean differences were statistically significant ($p<0.01$).

Results from the multivariate regression model are presented in Table 3. The statistical model included GPU as a random variable to account for the ICC, although the value was small (ICC=0.009). After adjustment for individual- and community-level covariates, participants living in an area without a CIA policy had an 8% increased risk of smoking initiation over time, compared to participants living in an area with a CIA policy ($p=0.04$). Age was a highly significant predictor of smoking initiation, as every one year increase in age was associated with a 43% increased risk of smoking initiation over time ($p<0.01$). Parental smoking was a significant predictor of smoking initiation, with a 61% increased risk of initiation with a mother who smokes, and a 78% increased risk for a father who smokes, adjusted for all covariates ($p<0.01$ and $p<0.01$, respectively). A home smoking ban for residents and/or guests in the home reduced the risk of smoking initiation by 6%, after covariate adjustment ($p=0.03$). Having any close friends who smoke had a highly significant dose-response relationship with smoking initiation, with an increase in risk of initiation as the number of close friends who smoke increased.

DISCUSSION

CIA policies are known to protect workers and the public from exposure to ETS, and are deemed the most effective means to do so. [14] Cross-sectional findings at the local and state level have demonstrated a reduction in youth smoking behaviours associated with local CIA policies. [8,22,23] Our findings support the longitudinal results from Siegel and colleagues that suggest that local CIA policies reduce youth smoking behaviours over time. [19] As noted by Wakefield and Forster, the use of a prospective cohort study provides temporal evidence for the causal association between CIA policies and youth smoking behaviours. [24]

Although our findings are consistent with the direction of previous studies, the magnitude of the protective effect from this study of CIA policies on youth smoking initiation was found to be more modest. Siegel et al found a 61% decreased adjusted risk of progression to regular smoking over a two year period. [19] Our findings suggested an 8% decrease in risk of youth smoking initiation over a roughly equivalent amount of time. One explanation the smaller magnitude in this study may be due to a smaller sample size of participants living in communities with local CIA policies in the current study. A second explanation may be the use of the smoking outcome measure of initiation rather than smoking progression, as progression may be more sensitive to the influence of policy changes. Finally, given that most youth in the sample were aged 16 or older at the time the first CIA policy was established, our study may miss the most critical period of smoking initiation between ages 10 and 15, [25] resulting in a bias toward the null hypothesis. These differences underscore the need for replication in other longitudinal studies to better characterize the magnitude of this association. Despite the difference in magnitude, an 8% decrease in smoking initiation has the potential for public health significance.

This study found that both individual- and community-level factors were significantly associated with youth smoking initiation. Our study supports the existing literature on the predictive value of parental and peer smoking status as well as home smoking restrictions. The use of both parental and peer smoking have been shown to serve different influences on youth based on their age and stage of smoking over time.[4–6,26] After accounting for other factors, our study found that home restrictions on smoking were associated with a 6% reduction in smoking initiation, independent of the influence of parental smoking, where an inconsistent protective effect has been demonstrated. [8,9,12,27,28] Multilevel analysis should be used in future studies to isolate modifiable factors, at any level, that may prevent youth smoking.

This study is not without limitations. As with any observational study, the lack of random assignment to policy status could allow for unidentified factors to confound the association between CIA policies and youth smoking initiation. While most of the major individual-level smoking predictors have been included in the analytic models, a number of community-level factors that are known to be associated with youth smoking prevention, including cigarette pricing, marketing of tobacco products, and anti-tobacco media campaigns and other tobacco control efforts were not measured within this study. [29–31] It is possible that the observed effects of CIA policies could be attributed to these or other unmeasured confounders, rather than to CIA policies.

This study focused on youth smoking initiation rather that regular smoking. While smoking initiation remains an important aspect of youth smoking behaviour, regular smoking uptake is the activity of interest for primary or secondary prevention. Smoking initiation is certainly required to progression to increased levels of smoking, although not all initiated smokers eventually become regular smokers.[32] Clearly, the prevention of youth becoming regular smokers is the most important means to reduce morbidity and later in life. The prevalence of regular smoking was too low to be meaningfully used as an outcome in this study sample; future research on CIA policies and progression to regular smoking during the critical periods during adolescence are needed.

A further limitation was that the level of complexity of the data and analytic method made the interaction between age, birth cohort, and period effects unable to be tested. However, the inclusion of both age and birth cohort effects very likely account for the strongest trends to be observed in these data.

Finally, while these study findings are statistically significant, interpretations should take into account the current body of literature when making an interpretation of current study findings with a limited sample size and a modestly significant finding. As over 500 local communities in the U.S. established CIA policies for 100% smokefree workplaces and many more worldwide, [33] replication of similar studies in different regions of the United States and other countries are needed to confirm these findings.

In spite of these limitations, this study suggests that CIA policies in Minnesota cities were associated with a reduction in youth smoking initiation over time. These findings are consistent with what has been suggested from cross-sectional data and limited longitudinal studies – youth living in areas where smoking is restricted in workplaces are less likely to initiate smoking than youth who live in areas without these smoking restrictions. Given the public health importance of the issue of tobacco use prevention, these findings provide additional evidence to use CIA policies as an intervention to protect employees and patrons from ETS exposure, as well as to reduce youth smoking. CIA policies, that effectively reduce harmful health effects of exposure to ETS, may have broader application as an effective tool for tobacco use prevention for young people.

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Table 1

Demographic characteristics of individuals in the Minnesota Adolescent Community Cohort sample, by clean indoor air policy status

Individual characteristics	Total (n=4,233)	Policy ‡ (n=1,028)	No policy (n=3,205)
Age at baseline			
11	14.1% (597)	12.8% (132)	14.5% (465)
12	17.1% (723)	16.4% (169)	17.3% (554)
13	17.2% (729)	17.7% (182)	17.1% (547)
14	17.2% (728)	18.3% (188)	16.8% (540)
15	17.2% (730)	17.0% (175)	17.3% (555)
16	17.2% (726)	17.7% (182)	17.0% (544)
Female	51.0% (2,151)	50.6% (520)	51.1% (1,631)
Race/ethnicity**			
White	84.9% (3,565)	71.7% (733)	89.1% (2,832)
Black	5.0% (210)	14.9% (152)	1.8 % (58)
American Indian	2.6% (109)	2.4% (24)	2.7% (85)
Asian	2.4% (99)	4.7% (48)	1.6% (51)
Hispanic/Latino	2.6% (107)	3.0% (31)	2.4% (76)
Other	2.6% (110)	3.3% (34)	2.4% (76)
Parental smoking at baseline			
Mother	24.7% (989)	25.0% (972)	24.6% (746)
Father	25.7% (916)	25.2% (790)	25.9% (717)
Home smoking policy			
In 2000	63.3% (2,265)	--	63.3% (2,265)
In 2006	78.1% (2,548)	76.1% (582)	78.7% (1,966)
Region of residence at baseline**			
Rural	51.3% (2,170)	10.7% (110)	64.3% (2,060)
Suburban	35.3% (1,496)	42.7% (439)	33.0% (1,057)
Urban	13.4% (567)	46.6% (479)	2.7% (88)
Smoking initiation			
At baseline	14.4% (522/3628)	--	14.4% (522/3628)
At 5 year follow-up	45.7% (1485/3248)	44.8% (340/759)	46.0% (1145/2489)

* $p<0.05$,

** $p<0.01$

‡ Policy defined by any local clean indoor air policy in the city of residence by the end of the study period.

Table 2

Population characteristics of geopolitical units (GPUs) in the Minnesota Adolescent Community Cohort sample, by clean indoor air policy status

Community-level characteristics◆	Total Mean (SD)	Policy‡ Mean (SD)	No Policy Mean (SD)
Population aged 18 and older (%)**	73.9% (4.7)	75.6% (6.4)	73.3% (3.8)
Population 25+ with college degree or higher (%)**	25.6% (12.8)	34.9% (14.5)	22.7% (10.6)
Percentage rural **	34.3% (33.2)	6.1% (16.4)	43.3% (32.1)
Percentage White race **	89.4% (14.0)	73.3% (21.8)	92.9% (7.4)
Median income **	$48,546 (14,640)	$50,837 (15,407)	$47,811 (14,311)

* p<0.05,

** p<0.01

‡ Policy defined by any local clean indoor air policy in the city of residence by the end of the study period.

◆ Census 2000 [1]

Table 3

Smoking initiation among Minnesota Adolescent Community Cohort by clean indoor air policy status [§]

Predictor variables	Adjusted OR (95% CI)[‡]
Main explanatory variable	
No clean indoor air policy	1.08 (1.00 – 1.16)*
Individual level variables	
Age in years	1.43 (1.41 – 1.44) *
Cohort (age at baseline)	
11	0.64 (0.52 – 0.79) *
12	0.91 (0.77 – 1.08)
13	0.78 (0.66 – 0.92) *
14	0.75 (0.64 – 0.92) *
15	0.65 (0.55 – 0.77) *
16	Reference
Male gender	0.98 (0.88 – 1.08)
Race/ethnicity	
Black	0.35 (0.25 – 0.50) *
American Indian	2.98 (1.98– 4.25) *
Asian	0.42 (0.29 – 0.62) *
Hispanic/Latino	0.85 (0.60 – 1.19)
Other race	0.92 (0.64 – 1.33)
White	Reference
Parental smoking at baseline	
Mother	1.61 (1.41 – 1.85) *
Father	1.78 (1.56 – 2.03) *
No smoking in the home	0.94 (0.89 – 0.99) *
Number of close friends who smoke	
4	5.14 (4.74 – 5.57) *
3	3.40 (3.16 – 3.65) *
2	2.48 (2.35 – 2.62) *
1	1.67 (1.59 – 1.75) *
0	Reference

OR = Odds ratio, CI = Confidence interval

[§] Smoking initiation defined as ever smoking at least one cigarette

[‡] Adjusted by percentage of population 18 and older, percentage college educated or greater, percentage rural, percentage White race, and median income.

* $p<0.05$