Secondhand Smoke Exposure in Young People and Parental Rules Against Smoking at Home and in the Car

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ABSTRACT

Objectives. Secondhand smoke (SHS) exposure is an important cause of morbidity in children. We assessed the impact of family rules about smoking in the home and car on SHS exposure prevalence in students in grades six to 12.

Methods. We studied never-smoking young people (n=1,698) in the random sample cross-sectional South Carolina Youth Tobacco Survey, a 2006 survey of middle and high school students in South Carolina.

Results. Overall, 40% of the students reported SHS exposure in either the home or car in the past week; among these, 85% reported exposure in cars. Subsequent analyses focused on students who lived with a smoker (n=602). Compared with those whose families prohibited smoking in the home or car, SHS exposure prevalence was 30% ($p<0.0001$) higher for households with smoke-free rules for only one place (home or car) and 36% ($p<0.0001$) higher for households with no rules. Compared with students from households with strict rules, SHS exposure prevalence was 48% greater ($p<0.0001$) among those with only partial rules against smoking in the home or car, and 55% ($p<0.0001$) greater among those from households with no rules. Similarly, compared with students with strict family rules for home and car that were adhered to, SHS exposure prevalence was significantly higher ($p<0.0001$) among students when only one or no rules were followed.

Conclusions. Young people from families that made and enforced strong rules against smoking in homes and cars were much less likely to report SHS exposure. Parents would be wise to endorse and enforce strong smoke-free policies for both homes and cars.

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Secondhand smoke (SHS) exposure is associated with many adverse health effects on children including sudden infant death syndrome, respiratory infections, asthma, and otitis media.[1] The established negative effects of SHS on child health have led the American Academy of Pediatrics[2,3] and the American Medical Association[4] to urge pediatricians and physicians in other medical specialties to assist parents in protecting their children from tobacco smoke.

The two places where children may be at greatest risk of SHS exposure are family homes and cars. One way that parents can protect their children from SHS exposure is to make rules prohibiting smoking in these places. Thus far, studies of rulemaking have tended to focus on SHS exposure in homes,[5–14] with results suggesting that establishing strong smoke-free rules in homes is a promising strategy to reduce children's household exposure to SHS.

Given the concentrated pollution levels found within the small enclosed area of a car,[15] rules to protect children against SHS exposure in cars may be important. The study of children's exposure to SHS in cars is a timely topic given that some states, such as Arkansas, California, Louisiana, and Maine, have enacted legislation against smoking in the car when children are present. However, cars have received relatively scant attention from researchers as a source of SHS exposure. Little is known about the prevalence of SHS exposure in cars, let alone whether rules prohibiting smoking in cars are beneficial in reducing SHS exposure in young people. Previous studies to report on the relationship between rules against smoking in the car and SHS exposure generated promising findings, indicating that smoking bans in cars were associated with a sevenfold decrease in children's SHS exposure[13] and significant reductions in salivary cotinine levels, a biomarker of SHS exposure.[16]

Family rules concerning smoke-free homes and cars can be effective toward establishing a smoke-free environment only to the extent that such rules are enforced. Few studies have considered the impact of both rulemaking and rule enforcement on SHS exposure. The only previous report to explore how completeness of smoke-free rules affects SHS exposure was not a study of child SHS exposure.[5] To address these current gaps in the evidence, we assessed the influence on children's SHS exposure of family rulemaking and rule enforcement related to smoking in the home and in the car.

METHODS

We based our study on analyses of data obtained from a two-stage cluster sample survey of tobacco use among middle and high school students in South Carolina. The South Carolina Youth Tobacco Survey (SC YTS) is part of the National Youth Tobacco Survey school-based survey program sponsored by the Centers for Disease Control and Prevention (CDC), and is primarily designed to characterize the prevalence of smoking in young people.[17]

The SC YTS is coordinated by the South Carolina Department of Health and Environmental Control; this article is based on the 2006 SC YTS data. The 2006 SC YTS questionnaire instrument was a self-administered questionnaire comprising 82 closed-ended, categorical items. Most of these are CDC core items that have been validated and field-tested, with selected items added for the South Carolina survey. The added items have usually also been field-validated and field-tested, such as items from the California Tobacco Survey. The questionnaire included demographic characteristics (e.g., age, gender, race/ethnicity, and grade in school); a thorough characterization of young people's smoking practices, including initiation, current use, cessation, and attitudes toward smoking and future intentions to smoke; exposure to media influences related to smoking; and the items related to SHS exposure and household rules about smoking in the home and car that formed the basis of our study. These secondary data analyses were conducted with Institutional Review Board approval from the Medical University of South Carolina.

Sampling strategy

In South Carolina, middle school comprises sixth through eighth grades and high school comprises ninth through 12th grades. We used a two-stage sample cluster design to select a random sample of all middle school and high school students in South Carolina. From the initial pool of all regular public schools, 50 middle schools and 50 high schools were randomly selected using probability weights assigned according to the number of students in each school. Of the 100 schools selected in the first sampling stage, 80% agreed to participate. From within the participating schools, two classes were randomly selected from all second-period classes in each school in the second stage of sampling. The total target population for the survey thus comprised all the students enrolled in the randomly selected second-period classes in the randomly selected schools.

We used a passive parental consent process, with students eligible to participate unless a parent/guardian indicated otherwise. Within the classroom during the protocol, student participation was voluntary and, therefore, participation indicated assent. The survey was anonymous, with no personal identifying information (e.g., names and addresses) collected. Overall, 84% of eligible students in the participating schools participated in the survey.

For this study, the independent variables of primary interest were (*1*) rules regarding smoking in the home and car and (*2*) whether these rules were followed. Additional control variables included gender, race/ethnicity, age, grade, and living with a smoker.

The outcome for this study was the prevalence of SHS exposure during the past week in the home and in the car. We measured the study outcome of SHS exposure by validated questionnaire items that assessed how many days out of the past seven the respondent reported being in the same room at home or rode in a car with someone who was smoking cigarettes; for data analyses, these variables were dichotomized into any vs. no exposure. SHS exposure was further classified as none, in the home only, in the car only, or in both the home and the car. The questionnaire item about car exposure specifically referred to ". . . ride in a car with someone who was smoking cigarettes" and so did not focus solely on the family car.

From the total of 2,748 students who completed the survey, the study population was restricted to 1,808 never smokers. Students who reported having never smoked a whole cigarette were considered to be never smokers. The analysis subpopulation was further restricted to subjects with complete data on the aforementioned variables. A total of 1,698 students were included in the study.

We assessed rules about smoking inside the home by asking respondents if there were no rules in the home or if smoking was (*1*) not allowed anywhere inside the home (hereafter referred to as "strict rules"), (*2*) allowed in some places or at some times (hereafter referred to as "partial rules"), or (*3*) allowed inside the home anywhere and at any time. We used a similarly worded item with the same categories to characterize whether there were no rules, partial rules, or strict rules for smoking in the car. We assessed enforcement of smoke-free rules by asking respondents questions concerning how many out of the past seven days someone smoked in his/her (*1*) home and (*2*) car when they were not supposed to; for the data analyses, these two variables were dichotomized into any vs. no exposure. We then combined these two dichotomous variables into a single variable to characterize the number of rules followed (i.e., "enforcement" of existing rules) according to the number of rules followed (i.e., zero, one, or two rules). In the questionnaire items about rules in the car, the wording referred to "the car you drive the most," referring non-drivers to "the car driven by a parent or guardian that you ride in the most;" the item about rule enforcement referred to "one of your household vehicles." The study population comprised predominantly Caucasians and African Americans, so students in other racial/ethnic groups were classified as "other."

Data analyses

The data analyses had three primary objectives. The first was to estimate the prevalence of SHS exposure among never-smoking young people in South Carolina overall and according to where the SHS exposure took place: only in the home, only in the car, or in both the home and the car. The second objective was to estimate and compare the prevalence of SHS exposure among never-smoking young people in South Carolina who resided with a smoker, according to household rules regarding smoking in the home and/or car. For these analyses, rules were classified as "smoking is allowed in neither the home nor car," "smoking is allowed in either the home or car (but not both)," or "the family had no rules." The third objective was to estimate and compare the prevalence of SHS exposure among never-smoking young people in South Carolina who lived with a smoker, based on rule completeness (i.e., strict, partial, or none) and enforcement of existing rules.

To compare the prevalence of SHS exposure among exposure categories, we assessed the significance of the difference in SHS exposure prevalence using a t-test testing the null hypothesis that the contrasted percentage was zero. We also performed analyses stratified by age, gender, grade in school, and race/ethnicity. For the subpopulation of never smokers living with a smoker, we assessed the presence of interaction between key demographic variables and rulemaking as they related to SHS exposure. Specifically, we constructed a logistic regression model of the log odds of SHS exposure as a function of rulemaking, the demographic variable of interest, and their interaction, and we then assessed the significance of the interaction using a Wald test.

We performed all analyses using SUDAAN®[18] to account for the survey's complex sample design. All tests were two-sided, and we based statistical significance on an alpha-level of 0.05. We used R software for graphic displays.[19]

RESULTS

A total of 1,698 middle and high school students (sixth through 12th grades) were included in the study. The racial/ethnic composition was primarily white (54%) and African American (41%). Almost all (92%) of the students felt that SHS exposure was harmful, and 36% reported residing with a smoker (Table 1).

Overall, 40% of young people reported being exposed to SHS during the past seven days (Table 2). Of these, slightly more than half reported exposure to SHS in both the home and car. Of students who reported exposure to SHS in only one place, two-thirds reported exposure only in the car. No significant variation in reported SHS exposure was observed according to gender, race/ethnicity (African American vs. Caucasian), age, or grade. A strong determinant of reported SHS exposure was residing with a smoker vs. not residing with a smoker (73% vs. 21%). For this reason, and because rulemaking and rule enforcement were most relevant to homes in which smokers lived, subsequent analyses of the relationship between rulemaking and rule enforcement were limited to students who reported living with a smoker.

Table 1. Descriptive characteristics of never-smoking middle and high school students: South Carolina Youth Tobacco Survey, 2006 (*n*=1,698)

Characteristics	*Frequency*[a]	*Percent*[b] *(SE)*
Gender		
Female	925	52.2 (2.0)
Male	773	47.8 (2.0)
Race/ethnicity		
White	908	53.9 (3.1)
African American	659	41.1 (3.1)
Other	131	5.1 (0.5)
Age (in years)		
11–12	359	20.7 (2.7)
13–14	615	33.9 (2.5)
15–16	508	29.9 (1.8)
≥17	216	15.6 (1.9)
Grade		
6	316	18.3 (3.2)
7–8	628	32.7 (3.2)
9–10	483	29.8 (2.7)
11–12	271	19.2 (2.1)
Lives with a smoker		
Yes	602	35.9 (2.0)
No	1,060	64.1 (2.0)
Thinks SHS is harmful		
Yes	1,549	91.6 (0.9)
No	140	8.5 (0.9)

[a]Frequencies are unweighted.

[b]Percentages for some variables do not sum to 100 due to rounding.

SE = standard error

SHS = secondhand smoke

Table 2. Prevalence of SHS exposure of never-smoking middle and high school students: South Carolina Youth Tobacco Survey, 2006 (*n*=1,698)

	Prevalence of SHS exposure[a] *Percent (SE)*			
Characteristics	*Overall*	*Home only*	*Car only*	*Both*
Total	40 (2.0)	6 (0.8)	12 (0.9)	22 (1.6)
Gender				
Female	40 (2.4)	6 (1.0)	12 (1.3)	23 (2.2)
Male	39 (2.1)	7 (0.9)	13 (1.4)	20 (1.6)
Race/ethnicity				
Caucasian	40 (2.9)	6 (1.0)	12 (1.4)	23 (2.3)
African American	40 (2.3)	7 (1.1)	12 (1.7)	21 (2.0)
Other	29 (4.2)	3 (1.2)	14 (4.4)	12 (3.6)
Age (in years)				
11–12	39 (4.4)	5 (1.6)	13 (2.1)	21 (2.9)
13–14	41 (2.6)	5 (1.1)	12 (1.8)	24 (2.1)
15–16	40 (2.3)	6 (1.3)	11 (1.2)	22 (2.2)
≥17	37 (6.1)	9 (2.6)	12 (2.3)	16 (4.9)
Grade				
6	46 (5.0)	6 (1.3)	16 (2.5)	25 (3.0)
7–8	38 (2.4)	5 (1.0)	10 (1.6)	23 (1.6)
9–10	39 (2.5)	5 (1.0)	12 (1.5)	22 (2.5)
11–12	37 (5.1)	9 (2.4)	12 (2.0)	16 (4.1)
Lives with a smoker				
Yes	73 (1.8)	11 (1.9)	12 (1.4)	51 (2.4)
No	21 (1.8)	3 (0.7)	12 (1.3)	5 (0.7)

[a]Percentages for exposure locations (home only, car only, and both) may not sum to the overall percent due to rounding.

SHS = secondhand smoke

SE = standard error

Having any rules (e.g., partial or strict) limiting smoking in homes and cars was associated with a significantly lower prevalence of reported SHS exposure. Compared with students who reported their families had no-smoking rules in both the home and the car, the reported prevalence of SHS exposure was 30% (85% vs. 55%, $p<0.0001$) higher in those who reported their families had rules for only the home or only the car, and 36% (91% vs. 55%, $p<0.0001$) higher in those who reported their families had no rules at all (Table 3). This general pattern of association was seen consistently within strata defined by gender, race/ethnicity, age, and grade level. For example, the reported SHS exposure prevalence increased 20% or more in all categories defined by these variables except for "other" race/ethnicity and the youngest age group.

In addition to whether or not rules were made, we further investigated the role in SHS exposure of whether the rules were strict, partial, or nonexistent, and among those living in households with rules, whether or not the rules were enforced (Figure). Both of these factors were

strongly and statistically significantly associated with students' reported SHS exposure. Specifically, compared with students who reported strict household rules, the reported prevalence of SHS exposure was significantly greater not only among those who reported no household rules (91% vs. 36%, $p<0.0001$), but also among those who reported only partial household rules against smoking in the home or car (84% vs. 36%, $p<0.0001$). Similarly, compared with students who reported being from households with two rules that were made and adhered to, the prevalence of reported SHS exposure was substantially higher among those who reported being from households where only one rule was followed (82% vs. 43%, $p<0.0001$) and where no rules were followed (97% vs. 43%, $p<0.0001$).

DISCUSSION

In our study of South Carolina middle and high school students who never smoked a whole cigarette, the prevalence of reported SHS exposure was substantial. Two out of five nonsmoking students reported being exposed to SHS either in the home, car, or both. The prevalence of reported SHS exposure in our population of never smokers mirrored the results previously reported in Texas, where 40% of middle and high school students reported exposure to SHS at home or in cars.[20] The overall high prevalence of reported SHS exposure emphasizes the need to develop effective strategies to reduce SHS exposure to prevent young people from illnesses caused by SHS.

A noteworthy finding was that among those who reported exposure to SHS, 85% were exposed in cars, either in combination with exposure in the home or solely in cars. In the lone previous study to evaluate this issue, cars were also observed to be a major source of SHS exposure, with 26% of young people exposed to SHS in cars compared with 23% exposed to SHS in homes.[21] The high prevalence of SHS exposure in cars emphasizes the importance of including rules against smoking in cars to protect young people from SHS exposure. The major contribution of exposure in cars to young people's overall SHS exposure has thus far been underappreciated.

Table 3. Prevalence of reported SHS exposure according to reported smoke-free rules in the home and/or car among never-smoking middle and high school students who live with smokers: South Carolina Youth Tobacco Survey, 2006

		Prevalence of reported SHS exposure								
			Rules (partial or strict)			*Prevalence difference*				
Characteristics	N	*Overall*	*A Home and car (n=268) Percent (SE)*	*B Home or car (n=154) Percent (SE)*	*C No rules (n=180) Percent (SE)*	*B–A*	P-*value*[a] *B–A*	*C–A*	P-*value*[a] *C–A*	P-*value*[b]
Total	602	73 (1.8)	55 (3.6)	85 (2.3)	91 (2.0)	30	<0.0001	36	<0.0001	
Gender										
Female	329	75 (2.3)	56 (4.8)	85 (4.4)	93 (2.6)	29	0.0009	37	<0.0001	0.72
Male	273	71 (3.1)	53 (5.5)	86 (4.4)	88 (3.4)	33	0.0001	35	<0.0001	
Race/ethnicity										
Caucasian	338	80 (2.3)	62 (3.7)	92 (3.2)	92 (2.1)	30	<0.0001	30	<0.0001	0.49
African American	230	66 (2.6)	47 (6.2)	75 (5.4)	91 (3.0)	28	0.015	44	<0.0001	
Other	34	53 (8.7)	43 (11.3)	91 (7.6)	52 (22.3)	48	0.0001	9	0.72	
Age (in years)										
11–12	128	70 (4.7)	56 (8.2)	66 (9.6)	95 (3.9)	10	0.42	39	0.0002	0.0008
13–14	221	75 (4.2)	52 (6.4)	91 (3.2)	88 (4.2)	39	<0.0001	36	<0.0001	
15–16	186	74 (2.3)	53 (4.7)	89 (2.5)	97 (1.9)	36	<0.0001	44	<0.0001	
≥17	67	75 (6.0)	61 (9.8)	94 (5.5)	81 (8.5)	33	0.005	20	0.11	
Grade										
6	124	77 (4.9)	62 (8.3)	82 (8.7)	94 (3.8)	20	0.024	33	0.0012	0.35
7–8	227	72 (3.5)	53 (6.5)	81 (4.5)	89 (4.4)	29	0.0037	36	0.0002	
9–10	168	71 (3.4)	48 (4.7)	93 (3.8)	93 (3.1)	45	<0.0001	45	<0.0001	
11–12	83	76 (5.1)	63 (7.9)	86 (4.7)	87 (7.8)	23	0.01	24	0.04	

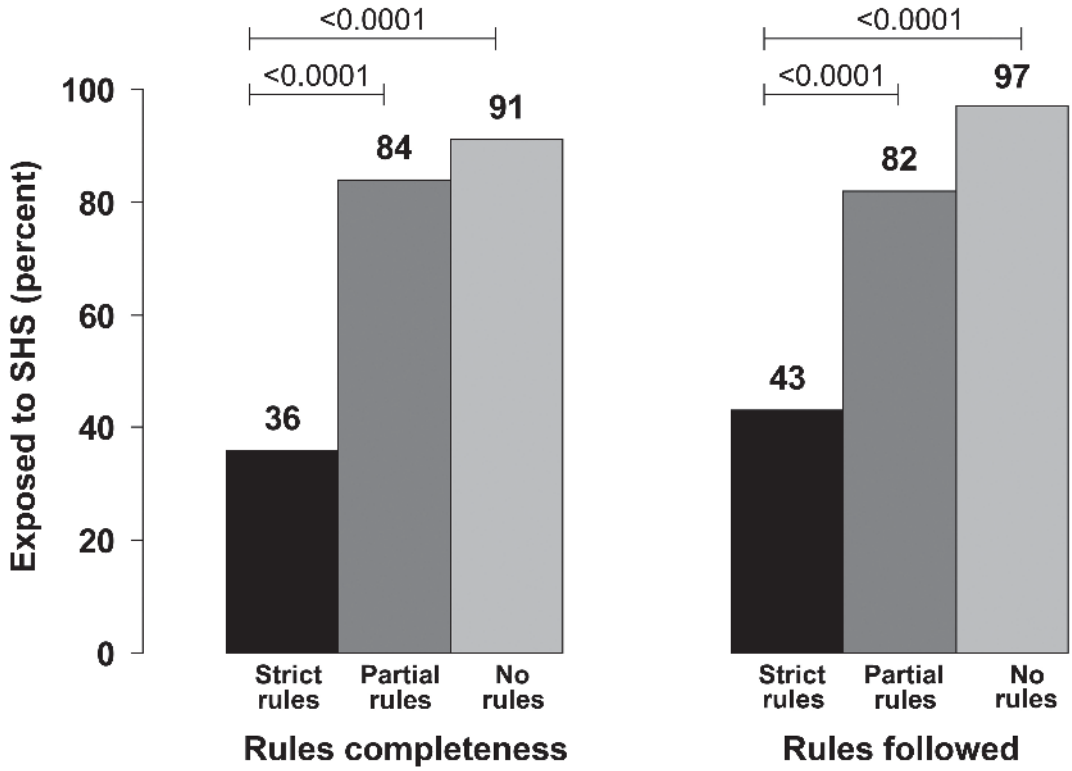
[a]*P*-values were obtained from testing the null hypothesis that there is no difference in the SHS exposure in the two population subgroups.

[b]*P*-values were obtained using the Wald test for interaction of variable of interest and rulemaking in a logistic regression modeling the probability of exposure to SHS and having as covariates the variable of interest, rulemaking variable, and their interaction.

SHS = secondhand smoke

SE = standard error

Figure. Prevalence of reported SHS exposure according to rule completeness (*n*=602) and, among households with rules, by the number of rules followed ("rule enforcement") (*n*=422) among never-smoking middle and high school students who live with smokers: South Carolina Youth Tobacco Survey, 2006



SHS = secondhand smoke

The results of our study indicate that making and enforcing smoke-free rules was a strategy that was associated with a significantly lower likelihood of students reporting SHS exposure in both the home and the car. The presence of smoke-free rules both in the home and in cars was associated with a lower prevalence of reported SHS exposure than if rules were made for only one or neither of these places. Ours is the first study to jointly consider both home and car exposure in this way. In a previous study, home and car smoke-free policies were evaluated independently but not jointly, and each was observed to be associated with significantly lower SHS exposure.[13] In a study of parents in Chicago, Illinois-area pediatric practices, 50% reported home smoking bans and 58% reported car smoking bans, with the prevalence of bans significantly lower in households in which a smoker resided and in which the parents had fewer years of education.[22] Similar associations were noted in a study of parents in Greece.[23]

In our study, only strict rules were associated with a markedly decreased prevalence of reported SHS exposure. That is, reported SHS exposure among children from families with less stringent (partial) rules was substantially higher than among those from families with strict rules. With respect to smoke-free rules in the home, the results of the present study corroborate the results previously observed by others indicating that compared with those with strict rules, young people's SHS exposure in homes is higher when only partial smoke-free rules are in place.[5–8,11–13] Biener et al. found that young people's mean weekly hours of SHS exposure were lowest when a full ban against smoking in the home was in place (2.4 hours) compared with partial bans (12.7 hours) or no bans (33.2 hours).[7]

We obtained our results by jointly assessing reported SHS exposure in homes and in cars and found that the associations previously observed in homes also seem to extend to cars. Specifically, the results of our study demonstrate that the reported prevalence of SHS exposure in cars is lower in young people from families with strict smoke-free car rules compared with those from families with only partial rules or no rules at all. In previous studies of this relationship, parental

reports of car smoking bans were associated with a significantly lower prevalence of SHS exposure[13] and reductions in children's salivary cotinine levels, a biomarker of SHS exposure.[16] In a study of low-income families in Georgia using qualitative interviews, many families were found to not even have discussed rules about smoking in the car.[24]

The association between smoke-free rules and reported exposure to SHS depended on the degree of rule enforcement. The prevalence of reported SHS exposure among children from families with rules that were not strictly enforced greatly exceeded the exposure of those from families in which rules were made and followed in both the home and the car. No previous studies of young people have investigated the impact of the actual enforcement of smoke-free rules on SHS exposure. In a sample of Chinese American adults in New York City, enforcement of all types of home smoking rules (e.g., strict or partial) was associated with lower exposure to SHS compared with no rules.[5]

Strengths and limitations

A strength of this study was that it was a random sample of a statewide population of students and that the population was racially/ethnically diverse, comprising 41% African Americans. We relied on young people's reports of family smoking policies and personal SHS exposure, which is likely to be a more objective measure than relying on parental reports.

This study was subject to certain limitations. The study design was cross-sectional, with the independent and dependent variables measured at a single point in time. Thus, the temporal sequence between reported family rules and reported SHS exposure cannot be established, although to the extent that our observations were true, it seems likely that household rules would precede current reports of SHS exposure. Our assessment of smoke-free rules in cars referred primarily to family cars, but the actual measurement of SHS exposure in cars was not specific to family cars. This differentiation could potentially distort the study findings concerning SHS exposure in cars. However, the majority of the study population was not of driving age, and no marked variability was observed in the prevalence of SHS exposure in cars by age or grade, which suggests that this limitation is not likely to have had a major influence on the study findings.

Measurements of household rules about smoking in the home and car and of SHS exposure were based on student reports. To the extent that this measurement resulted in nondifferential misclassification, this would have biased the observed association toward the null, so the true associations may actually be stronger than the observed associations. Another potential source of bias was introduced by nonresponse, but to the extent that nonparticipation was nondifferential with respect to the independent and dependent variables, this would also have biased the observed associations toward the null.

CONCLUSIONS

A substantial proportion of young people reported exposure to SHS not only in homes, but also in cars. Compared with children from families that had strictly enforced smoke-free rules put into place both at home and in cars, the reported prevalence of SHS exposure was significantly higher among those from households with no rules put in place, with rules put in place but not for both the home and car, or with rules put in place but without enforcement. Consequently, to effectively reduce the likelihood that young people will be exposed to SHS, comprehensive rulemaking and rule enforcement should extend to both cars and homes.

The top priority to prevent SHS exposure among children and adolescents is for parents and guardians to stop smoking cigarettes. The results of our study are relevant to families in which adult household members are unable or unwilling to quit smoking, or where there is potential exposure to SHS from visitors who do not reside in the household. In these situations, educational interventions that teach parents to endorse and enforce strict smoke-free rules for both the home and car could have a major impact on preventing illnesses caused by SHS exposure.

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