School Absenteeism Among Children Living With Smokers

WHAT'S KNOWN ON THIS SUBJECT: Tobacco smoke exposure leads to respiratory illnesses in children. Geographically and demographically limited studies have suggested a link between living with a smoker and school absenteeism.

WHAT THIS STUDY ADDS: In a nationally representative sample, we established that absenteeism among children aged 6 to 11 years living with smokers could be reduced 24% to 34% by eliminating smoking in their homes. Caregivers' lost wages/time due to child absenteeism was valued at $227 million per year.

abstract

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OBJECTIVE: Involuntary tobacco smoke exposure causes substantial morbidity in children. We hypothesized that children exposed to tobacco smoke in the home would have increased school absenteeism with associated costs due to lost caregiver wages/time.

METHODS: We analyzed data on health and absenteeism among schoolchildren aged 6 to 11 years identified in the 2005 National Health Interview Survey (NHIS). We used multivariate models to assess the relationships between adult-reported household smoking and child health and school absenteeism. Analyses were adjusted for children's and parents' demographic and socioeconomic characteristics. The value of lost caregiver time was estimated by using self-reported employment and earnings data in the NHIS and publicly available time-use data.

RESULTS: Children living with 1 or ≥2 adults who smoked in the home had 1.06 (95% confidence interval [CI]: 0.54–1.55) and 1.54 (95% CI: 0.95–2.12) more days absent from school per year, respectively, than children living with 0 smokers in the home. Living with ≥2 adults who smoked in the home was associated with increased reports of having ≥3 ear infections in the previous 12 months (adjusted odds ratio [aOR]: 2.65 [95% CI: 1.36–5.16]) and having a chest cold in the 2 weeks before interview (aOR: 1.77 [95% CI: 1.03–3.03]) but not with having vomiting/diarrhea in the previous 2 weeks (aOR: 0.93 [95% CI: 0.45–1.89]). Caregivers' time tending children absent from school was valued at $227 million per year.

CONCLUSIONS: Tobacco smoke exposure has significant consequences for children and families above and beyond child morbidity, including academic disadvantage and financial burden. *Pediatrics* 2011;128:650–656

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KEY WORDS

secondhand smoke, school-aged children, caregivers, economic burden

ABBREVIATIONS

TSE—tobacco smoke exposure
NHIS—National Health Interview Survey
aOR—adjusted odds ratio
CI—confidence interval

Dr Levy conceived of and designed the study, acquired, analyzed, and interpreted the data, drafted the article and critically revised it, and takes full responsibility for the final submitted manuscript; Drs Winickoff and Rigotti assisted in interpreting the data and revising the manuscript. Each author accepts full responsibility for the final submitted manuscript.

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Involuntary tobacco smoke exposure (TSE), whether through secondhand smoke or third-hand smoke, is a common threat to child health. Thirty-four percent of children live with a smoker and at least 56% of children aged 3 to 11 years have detectable levels of serum cotinine, a preferred marker of TSE.[1,2] There is no safe level of TSE.[3] TSE has been linked to a range of adverse health outcomes in school-aged children, particularly respiratory conditions. These include otitis media, bronchitis, bronchiolitis, wheeze, cough, asthma, and pneumonia.[3–8] Long-term adverse outcomes include cognitive impairment, reduced lung function and development, and deficits in reading, math, and visiospacial reasoning.[7,9–13] Often, the conditions caused by TSE result in the need for medical care.[14–17]

School absenteeism may be used as a general marker of morbidity that is easily assessed using survey methods.[18] Geographically and demographically limited studies indicate that TSE exposure leads to school absenteeism in young children, and there has been some investigation of specific mechanisms.[19,20] Not only is school absenteeism a measure of health, it also has non-health effects. Children frequently absent from school because of asthma or other chronic illnesses have poorer school performance, as well as poorer social and intellectual growth.[21–23] School absenteeism may also stress families emotionally and financially by inducing caregivers' workplace absenteeism.

We analyzed federal survey data to provide the first national estimates assessing the effect of smoking in the home on school absenteeism, the mechanism through which TSE induces absenteeism, and the value of wages lost for caregivers who miss work to care for children home sick from school because of TSE. We hypothesized that children exposed to tobacco smoke in the home would have increased school absenteeism with associated costs because of lost caregiver wages/time.

METHODS

Data

We examined data from the 2005 National Health Interview Survey (NHIS). The NHIS is an annual, nationally representative in-person survey. In each sampled household, additional sampling identifies 1 adult and 1 child to provide detailed health information. For children, a knowledgeable adult in the household, usually a parent, answered questions about the child. We restricted our analysis to children aged 6 to 11 years who were attending school. We excluded children aged 12 years and older to reduce the likelihood that tobacco smoke exposure was due to the child's own smoking.

Absenteeism was defined as the number of school days missed because of illness or injury during the 12 months preceding the interview. The NHIS does not contain biological data on TSE, such as serum cotinine. However, in a 2005 supplement to the NHIS, the survey asked the sample adult whether any residents of a household smoked inside the home, and if so, how many. Sample children living in a household with a sample adult who reported that residents smoked in the home were considered exposed to TSE. We assessed whether there was a dose response in our measure of TSE corresponding to the number of residents smoking in the home by defining exposure as 0 residents smoking in the home, 1 resident smoking in the home, or $\geq$2 residents smoking in the home.

To help connect school absenteeism with smoking in the home and to assess the robustness of our exposure measure, we also looked at specific health outcomes. Respondents reported on the sample child's overall health (fair or poor health versus excellent, very good, or good health) and indicated whether the child had $\geq$3 ear infections in the previous 12 months, a cold in the past 2 weeks, a current diagnosis of asthma, and whether the child had vomiting/diarrhea in the past 2 weeks. For children with asthma, respondents indicated the number of asthma attacks in the past year. On the basis of existing epidemiology studies, we hypothesized that the respiratory conditions (asthma, chest colds, ear infections) would be related to home smoke exposure, whereas vomiting/diarrhea would not.[3] To further assist in establishing the relationship between TSE and school absenteeism, we tested whether the relationship between the presence of smokers in the home and school absenteeism was mediated by the abovementioned illnesses according to the Baron and Kenny framework.[24] We controlled for illnesses that were significantly related to household smoking in models assessing the relationship between household smoking and absenteeism. Reductions in the magnitude of the relationship between household smoking and absenteeism when the illnesses were added to the regression models were taken as evidence that the illnesses mediated the relationship between household smoking and absenteeism.

Our analyses accounted for child, family, and geographic characteristics that might potentially confound the relationship between household smoking and absenteeism. We controlled for child's age, gender, race, and Hispanic ethnicity; census region; family poverty and parent education; and number of children in the home, family structure (single mother, other single parent, or other family structure), and number of unemployed adults in the home. We posit that family structure

and the number of unemployed adults in the home reflect the availability of potential caregivers when a child is sick.

Pearson χ^2 statistics were used to compare the characteristics of children who lived in homes with and without smoking and to make unadjusted comparisons of health states across household smoking values. We estimated multivariate regression models to assess the relationship between our outcomes and household smoking, controlling for child, family, and geographic characteristics. For our health outcomes, we estimated adjusted odds ratios (aORs) using logistic regression models. For number of school days missed, we estimated generalized linear models with a log link and the Poisson variance function. Confidence intervals (CIs) for regression coefficients were based on Wald tests. The mean number and the percentage of school days missed because of household smoking were calculated among children living in smoking households using predicted values from the estimated generalized linear model regressions. CIs for these statistics were based on the bootstrap method.[25] All analyses were performed using Stata 10.1 (Stata Corp, College Station, TX), accounting for the complex design of the survey.

Children's school absenteeism also has an economic cost because of caregivers' taking time off from work or other tasks to care for their children. Using established cost-of-illness methods,[26–29] we estimated the value of caregiver time by multiplying the predicted number of school days missed for each child in the sample by the value of a day of that child's caregiver's time. For caregivers who were employed, we valued time using his or her daily earnings as self-reported or imputed in the NHIS.[30] If a caregiver was unemployed, we assigned a value for his or her time based on lost household production (ie, cooking, cleaning, household management) as valued in the American Time Use Survey and the Occupational Employment Statistics program, and synthesized in the 2005 edition of *The Dollar Value of a Day: 2005 Dollar Valuation*.[31] Household production was valued according to what it would cost to hire someone else to complete the foregone household tasks. If time to care for a sick child came from a caregiver's leisure time rather than his or her household production time, we will have underestimated the economic cost of caring for the sick child because leisure time is valued slightly higher than household production time. The caregiver was defined as the mother or female guardian, if one was present, or the father/male guardian if there was no mother/female guardian in the home. This use yields a conservative estimate because women on average earn less than men,[32] and if a man was the caretaker for the child, the cost would be higher. Our estimates will also be somewhat conservative because we do not account for days of work missed to care for sick children during school vacations.

RESULTS

More than 14% of children in our sample, representing 2.6 million children in the United States, lived in a household in which at least 1 resident smoked inside the home; 8% had 1 household member who smoked in the home, and 6% had ≥2 household members who smoked in the home. Demographic distinctions between households with and without inside smoking were similar to those found when comparing smokers with nonsmokers (Table 1). Households with no indoor smoking tended to be more educated, have a higher income, and more likely to be Hispanic (all $P <$ .001). They were also less likely to have been in the south and more likely to have been in the west ($P <$ .001). Compared with households with 1 person smoking indoors, those with ≥2 people smoking indoors had higher incomes and were more likely to be white ($P <$ .001 and $P =$ .02, respectively, P values not shown in Table 1).

Living with a smoker was associated with both of our measures of school absenteeism (Table 2). The likelihood of missing any school was higher for those living in homes in which there was 1 person who smoked in the home (aOR: 1.68 [95% CI: 1.20–2.34]) than in homes where no one smoked indoors. The number of days a child was absent from school was significantly higher for those living in homes in which smoking took place than for those living in smoke-free homes, and greater numbers of household smokers led to increased absenteeism. Children living with exactly 1 person smoking in the home missed 1.06 (95%: CI 0.54–1.55) additional school days per year, and those living with ≥2 smokers missed 1.54 (95% CI: 0.95–2.12) more days of school per year than they would have if they lived in smoke-free homes. Among children living with exactly 1 or with at least 2 smokers, 24% (95% CI: 14–32) and 34% (95% CI: 24–43), respectively, of school days missed were attributable to residents' smoking.

In Table 3, we provide evidence that increased absenteeism among children living in homes in which smoking takes place is due in part to TSE-induced illnesses assessed in the NHIS. Living with a smoker was associated with both of our measures of respiratory infection, and there was modest evidence of a dose-response or threshold effect. The likelihood that a child had ≥3 ear infections in the previous 12 months increased with the number of residents smoking in the household, and was significantly higher among children with at least 2 people who

smoked in the home (aOR: 2.65 [95% CI: 1.36–5.16]). Reports of a chest infection in the 2 weeks before the interview were similar for children with 0 or 1 residents smoking in the home but were significantly elevated among children living with at least 2 people who smoked in the home (aOR: 1.77 [95% CI: 1.03–3.03]). An apparent relationship between living with 1 person smoking in the home and fair or poor self-reported health status was not statistically significant at the $P = .05$ level (aOR: 2.11 [95% CI: 0.93–4.79]). We were unable to detect any relationship between household smoking and prevalent asthma or asthma attacks among children with asthma. As hypothesized, we found no association between household smoking and whether the child had an episode of vomiting/diarrhea in the 2 weeks before the interview.

Evidence that the effect of household smoking on school absenteeism was partially mediated by respiratory tract infections is presented in Table 4. For models of any days of school missed or number of days of school missed as a function of household smoking, we added control variables for respiratory tract infections (≥3 ear infections in the past 12 months, a chest cold in the past 2 weeks, each of which had significant relationships with household smoking) to the models estimated in Table 2. These conditions were chosen on the basis of the significant relationships identified in Table 3. For the regression modeling of the relationship between any days of school missed and household smoking, the coefficient on having 1 household smoker increased 1.1%, but the coefficient on having at least 2 smokers in the home decreased by 23.2% when respiratory tract infections were included in the model. Similarly, for the regression modeling the number of days a child was absent from school as a function of household smoking, the coefficient on having 1 household smoker increased 1.9% when respiratory tract infections were included in the model, but the coefficient on ≥2 household smokers decreased by 16.7%.

TABLE 1 Characteristics of the Study Population

Characteristic	Residents Smoking in the Home			*P*[a]
	0 ($n = 2685$ [86%])	1 ($n = 237$ [8%])	≥2 ($n = 165$ [6%])	
Highest parent education				<.001
Less than high school	11	17	17	
High school	18	32	42	
Some post–high school	31	36	31	
College or more	40	16	9	
Household poverty status				<.001
≤125% FPL	16	33	23	
126%–200% FPL	14	16	22	
201%–400% FPL	27	24	34	
≥401% FPL	25	12	6	
Unknown	17	16	14	
Child ethnicity				
Hispanic	21	9	9	<.001
Non-Hispanic	79	92	91	
Race				
White	78	76	87	
Black	14	17	10	
Other	8	7	3	
Region				<.001
Northeast	17	18	13	
South	33	49	44	
Midwest	25	27	32	
West	25	6	10	
No. of children in household				.78
1	15	18	15	
2	42	43	46	
3	28	25	23	
≥4	15	14	16	
Parent/guardian				<.001
Single mother	16	30	3	
Other single parent	2	4	0	
Not single parent	81	66	97	
Unemployed adults in the home				.001
0	5	11	6	
1	40	47	32	
≥2	55	52	63	

All percentages in the table account for survey weights. FPL indicates federal poverty level.
[a] *P* values reflect a test of the hypothesis that the distribution of values for a characteristic was equal across all 3 smoking categories.

TABLE 2 Adjusted Relationships Between Household Smoking and Absenteeism

No. of Residents Who Smoke in the Home	Any Days Missed, No Injury/Poison, aOR (95% CI)[a]	TSE-Attributable Days Missed Among Children in Smoking Households, d (95% CI)	TSE-Attributable Percentage of Days (95% CI) Missed Among Children in Smoking Households
1	1.68 (1.20–2.34)[b]	1.06 (0.54–1.55)[b]	24 (14–32)[b]
≥2	0.94 (0.89–1.00)	1.54 (0.95–2.12)[b]	34 (24–43)[b]

Values were adjusted for parent education, income, number of children in the home, single mother, other single parent, child race/ethnicity, child age, and census region.
[a] The reference is 0 residents.
[b] $P < .05$.

For the economic analysis, we estimated that 69% of the caregivers were employed. The mean annual earnings of the employed caregivers was $20 087. In a year with 250 working days, this represents ~$80 per day. Assuming caregivers missed work

TABLE 3 Relationship Between Household Smoking and Child Health

Illness	Unadjusted % With Outcome				aOR (95% CI)[a]	
	Residents Smoking in the Home			P[b]	Residents Smoking in the Home[c]	
	0	1	≥2		1	≥2
≥3 ear infections previous 12 mo	4.4[d]	6.2[d]	10.3[d]	.006[d]	1.47 (0.81–2.70)	2.65 (1.36–5.16)[d]
Chest cold previous 2 wk	16.7	15.3	25.9	.05	0.84 (0.55–1.30)	1.77 (1.03–3.03)[d]
Current asthma	10.4	11.9	9.8	.78	1.18 (0.69–2.03)	1.07 (0.61–1.88)
Asthma attack in previous 12 mo (among children with asthma)	62.2	46.9	67.7	.30	0.65 (0.31–1.37)	1.70 (0.65–4.44)
Self-reported health is fair/poor	1.6[d]	5.0[d]	3.8[d]	.06	2.11 (0.93–4.79)	1.95 (0.47–8.12)
Vomiting/diarrhea previous 2 wk	5.5	6.1	5.7	.91	1.05 (0.60–1.86)	0.93 (0.45–1.89)

[a] Values are adjusted for parent education, income, number of children in the home, single mother, other single parent, child race/ethnicity, child age, and census region.
[b] P values reflect comparisons across all 3 smoking categories.
[c] The reference is 0 residents.
[d] $P < .05$.

TABLE 4 Changes in Exposure Coefficients With Addition of Respiratory Illness to Main Outcome Models

Exposure Measure	Any Days of School Missed			No. of Days of School Missed		
	Respiratory Illnesses Excluded	Respiratory Illnesses Included	% Change in Coefficient	Respiratory Illnesses Excluded	Respiratory Illnesses Included	% Change in Coefficient
1 resident smokes in the house	0.638	0.645	1.1	0.274	0.279	1.9
≥2 residents smoke in the house	0.366	0.281	−23.2	0.420	0.350	−16.7

Values adjusted for parent education, income, number of children in the home, single mother, other single parent, child race/ethnicity, child age, and census region.

each time a child stayed home from school because of TSE, we estimate the value of this lost work time was $176 million in 2005. The mean value of household production for unemployed caregivers was $51 per day.[31] The value of household production that would be missed to care for children sick because of TSE is estimated at $51 million for 2005.

DISCUSSION

Using national data, we present estimates of the relationship between household smoking and school absenteeism among children. Household smoking was associated with increased absenteeism overall, and as the number of residents smoking in the house increased, so did the number of school days missed by the children. We estimate that one-quarter to one-third of school days missed among children living with smokers are due to residents' smoking. We established a relationship between household smoking and 2 respiratory illnesses known to be associated with TSE exposure, and we identified modest evidence that these outcomes increased as the number of residents smoking in the home increased. At the same time, we found no relationship between household smoking and health problems unrelated to TSE exposure. The relationship between household smoking and absenteeism diminished when ear infections and chest colds were added to the model, suggesting the link between TSE and absenteeism is in part mediated by these 2 illnesses when there are 2 residents smoking in the home.

Our results largely confirm the findings of earlier regional studies. One, focused on children in southern California in 1996,[20] tracked school absences among fourth-graders to determine if they were due to respiratory illness, gastrointestinal illness, or other causes, and household smoking status was assessed by questionnaire in the same way it was assessed on the NHIS. The authors found that children living in households with smokers were at greater risk for absences due to respiratory illness but found no association between TSE exposure and nonillness absences. A second study, conducted among mostly Hispanic preschool through fifth grade students in Passaic, New Jersey, from 1997 to 2001, tracked the relationship between household asthma triggers and both asthma and absenteeism.[19] Using TSE and outcome measures similar to ours, the authors found the relative risk of absenteeism was higher for children with TSE. However, aside from race/ethnicity, there were no sociodemographic controls used in this study. Our study has strengths beyond these studies by using a national sample, a wider age range of children than the California study, and a more thorough range of sociodemographic control variables than the New Jersey study. Furthermore, we report differences in the number of absences due to illness for exposed and unexposed children,

establishing the magnitude of the problem, whereas the other studies reported only relative risks.

In our study, we did not find a significant association between household smoking and asthma prevalence or attacks. The California study did find an association between household smoking and lower respiratory tract illness with wheeze, but they did not report whether the relationship was statistically significant. The New Jersey study found a significant relationship between household smoking and asthma, but they focused on a high-risk asthma population. Our finding contrasts with the Surgeon General's 2006 meta-analysis linking parent smoking to asthma prevalence.[3] However, most individual studies included in the Surgeon General's analysis did not find statistically significant relationships between parent smoking and asthma prevalence; it was only in the pooled analysis that a significant finding emerged. Research on children with asthma has found that children with asthma-related morbidity have increased school absenteeism,[29,33–36] although there is mixed evidence on whether school outcomes are adversely affected.[33–35] Nevertheless, additional research is necessary to determine the extent to which the relationship between TSE and school absenteeism is mediated by asthma.

We did confirm predicted relationships between smoking in the home and respiratory tract infections as measured by frequent ear infections and recent chest colds. These measures only partially mediated the relationship between TSE and absenteeism. Absenteeism is thus a useful, if imperfect, proxy for a broader range of specific health conditions, and it provides a highly tangible measure of TSE-induced functional limitation.[18]

Although it is clear that the prevention of illness itself is reason enough to push further expansion of home-smoking bans, establishing the effects of TSE exposure on school absenteeism also highlights other preventable consequences of the smoking epidemic. There is some evidence that chronic absenteeism due to illness is associated with poorer school achievement,[34] although additional research is necessary to determine the extent to which the numbers of excess absences observed in the present study will lead to poor educational outcomes. Our finding that 24% to 34% of school absenteeism due to illness among children living in homes in which residents smoke is associated with TSE suggests that reductions in household smoking and overall smoking rates will greatly reduce the illness-related attendance problems of these exposed children.

Beyond its impact on individual children, absenteeism has consequences for families and society.[29,36] When young children are home from school, parents may miss time at work or have to find alternative sources of child care. Such a burden will be especially acute for low-income parents (nearly half of the smoking households in our population had family incomes $\leq$200% of the federal poverty level) and single parents (22% of the smoking households in our population were headed by single parents). Parents working low-paying jobs at small business may even be vulnerable to job loss. We conservatively estimated that $227 million worth of work/household production time may have been missed in 2005 to care for TSE-induced school absenteeism. In the event that parental circumstances prevent a sick child from staying home, illnesses may unnecessarily spread to the index child's classmates as well.

Our study is subject to several limitations. As is to be expected in a large national survey that was not designed with TSE in mind, our measure of TSE is imprecise. We do not have direct data on children's personal TSE as measured by cotinine levels, for example, and we could not assess exposure that may have taken place outside the home. Nevertheless, as the reported number of people who smoked in the home increased, so did the number of school days missed, even after accounting for factors affecting the availability of caregivers. Together with the mediation analysis and the absence of a relationship between TSE and nonrespiratory illnesses, this suggests that family members' self-reports of smoking in the home are a reasonably proxy for TSE. As with any observational study, there may be confounding factors that were not measured and not included in the analysis.

CONCLUSIONS

In this first national study, household smoking is significantly associated with school absenteeism among children, a broad measure of children's health status and a direct assessment of functional limitation. These absences may result in costly missed work/household time for parents in families, many of whom are low income, are already financially burdened by the daily cost of cigarettes. Overall, these results illustrate the extent of tobacco's impact on child and family well-being, highlighting academic disadvantage and financial burden in families in which parents smoke.

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