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Asthma and Tobacco: Double Trouble for Wisconsin Adolescents

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ABSTRACT

Background: Environmental tobacco smoke (ETS) exposure has been identified as a cause of asthma and a trigger of asthma attacks in children. We examined the relation of demographic and tobacco-related risk factors to both lifetime asthma diagnosis and the asthma attack rate among Wisconsin adolescents. The impact of asthma on adolescent school absenteeism was also examined.

Methods: Data used were from the 2004 Wisconsin Youth Tobacco Survey (n=3125), which was administered in a sample of Wisconsin public middle and high schools. Multivariable logistic regression was used to examine risk factors simultaneously.

Results: Self-reported lifetime asthma prevalence was 19% among Wisconsin adolescents. Thirty-five percent of adolescents with asthma reported having an asthma attack in the past 12 months. Living with a smoker was a significant predictor of lifetime asthma diagnosis and, among adolescents with asthma, daily ETS exposure was associated with a 2-fold increased risk of having an asthma attack. Being diagnosed with asthma did not deter adolescents from smoking and was a significant predictor of school absenteeism.

Conclusions: Asthma is an important health problem for Wisconsin adolescents. Tobacco-related risk factors contribute to the burden of the disease. Interventions to reduce smoking and ETS exposure targeted to adolescents and their guardians are needed. Better asthma control among adolescents could reduce school absenteeism.

INTRODUCTION

Asthma is a chronic respiratory disease characterized by intermittent wheezing episodes or attacks. It is one of the most common chronic diseases of childhood[1] and the chronic condition most likely to cause school absenteeism.[2] Exposure to environmental tobacco smoke (ETS) is one of the few identified causes of asthma in children and can trigger asthma attacks among children with asthma.[3]

In this paper, we used 2004 Wisconsin Youth Tobacco Survey (WYTS) data to measure self-reported asthma prevalence and the rate of asthma attacks among Wisconsin adolescents. We examined how tobacco use and ETS exposure among Wisconsin adolescents are related to asthma diagnoses and experiencing an asthma attack. The impact of asthma on school absenteeism was also assessed.

METHODS

The WYTS is part of the national Youth Tobacco Survey (YTS) administered by the US Centers for Disease Control and Prevention (CDC) to monitor tobacco-related behaviors among adolescents. The WYTS contains the core YTS questions, included in each participating state's questionnaire, and additional state-determined questions. In 2004, Wisconsin chose to include 2 asthma-related questions on the WYTS. The questions were: "Have you ever been told by a doctor or other health professional that you have asthma?" (response options were "yes," "no," and "not sure") and "During the past 12 months, have you had an episode of asthma or an asthma attack?" (response options were "I do not have asthma;" "No, I have asthma, but I have not had an episode of asthma or an asthma attack dur-

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ing the past 12 months;" "Yes, I have had an episode of asthma or an asthma attack during the past 12 months;" and "not sure").

Fifty public middle schools and 50 public high schools from across the state were randomly selected, with probability proportional to enrollment, and invited to participate in the 2004 WYTS. The Wisconsin Department of Health and Family Services (DHFS) contracted with the University of Wisconsin-Madison Medical School to administer the paper survey in randomly selected classes within the participating schools from February to May of 2004. The University's Institutional Review Board reviewed and approved the 2004 WYTS questionnaire and methodology.

In our analyses, the case definition for lifetime asthma, or the cumulative prevalence, was met if a WYTS respondent reported ever being diagnosed with asthma by a doctor or other health professional. Adolescents who reported a professional asthma diagnosis and confirmed on the second asthma question that they still had asthma met the case definition for current asthma, or the point prevalence. Respondents who reported a professional diagnosis of asthma and reported having experienced an asthma attack in the past 12 months met the asthma attack case definition. Respondents not diagnosed with asthma but reporting an asthma attack in the past 12 months (2% of respondents) were not included in asthma attack rate calculations.

To examine the associations between demographic and tobacco-related risk factors and the 3 outcomes of interest (lifetime asthma diagnosis, the asthma attack rate, and school absenteeism), each risk factor was first examined separately in relation to each outcome. These risk factors and potential confounding variables were then included in a multivariable logistic model with relevant interaction terms. Variables and interaction terms that were not statistically significant were removed from the full model to create the most parsimonious model for each outcome. Significance of bivariate relationships was assessed using the Wald chi-square test for independence. Significance of variables within the multivariable models was calculated using the Wald chi-square test. Results were deemed significant if the *P*-value was <0.05.

PC SAS® version 9.1 software was used for all analyses.[4] SAS procedures that take into account the complex survey design and the clustering of respondents within schools were used. Each WYTS respondent was assigned a survey weight by the CDC to account for the probability of being selected for the survey and to reflect the statewide school population by grade and gender. These survey weights were used to make inferences from the WYTS sample to all Wisconsin public middle and high schools and were used in all analyses.

RESULTS

Response Rate

Forty-three middle schools (86%) and 42 high schools (84%) agreed to participate in the survey.[5] Usable questionnaires were completed by 1682 of 1892 middle school students and 1443 of 1648 high school students. The combined overall middle and high school response rate for the 2004 WYTS was 75% when accounting for both the school and student response rates.

Asthma Prevalence and the Asthma Attack Rate

The self-reported lifetime asthma prevalence among Wisconsin public school adolescents in grades 6-12 in 2004 was 19%. Fifteen percent of Wisconsin public school adolescents reported currently having asthma (data not shown). Thirty-five percent of adolescents who reported currently having asthma, or 5% of Wisconsin public school adolescents overall, reported having an asthma attack in the past 12 months (Table 1).

Demographics—Adolescents of racial/ethnic minority groups reported a higher lifetime prevalence of asthma than non-Hispanic whites (whites) with the exception of non-Hispanic Asians/Pacific Islanders (Asians/Pacific Islanders) who reported the lowest lifetime asthma prevalence of any racial/ethnic group. Non-Hispanic African American (African American) and non-Hispanic American Indian (American Indian) adolescents reported the highest asthma attack rates. Female adolescents reported a slightly higher lifetime asthma prevalence than males (20% versus 18%) and a statistically higher asthma attack rate (6% versus 4%). Differences in self-reported lifetime asthma prevalence and asthma attack rates by grade were not statistically significant. Adolescents whose guardians had less than a high school education had the highest lifetime asthma prevalence rates. The asthma attack rate did not vary significantly by guardian education level.

Tobacco-Related Risk Factors—Adolescents who reported currently living with a smoker or spending time all of the past 7 days in the same room as someone smoking were more likely to report having ever been diagnosed with asthma and, among adolescents with asthma, having had an asthma attack in the past 12 months. Adolescents who had ever tried smoking had a statistically significant higher prevalence of asthma (22% versus 17%) and a slightly higher asthma attack rate.

Table 1. Lifetime Asthma Prevalence and Asthma Attack Rates by Respondent Demographics and Tobacco-Related Risk Factor Exposure, 2004 Wisconsin Youth Tobacco Survey

	Lifetime Asthma*			Asthma Attack Rate†		
	%	95% CI‡	Est. No. of Students§	%	95% CI	Est. No. of Students
Wisconsin Public School Adolescents Overall	**18.9**	**(17.5-20.3)**	**85,183**	**4.9**	**(3.9-5.8)**	**23,709**
Race/Ethnicity						
White	17.6	(15.8-19.3)	63,897	4.9	(3.9-5.9)	19,037
African American	30.2	(25.7-34.7)	11,957	6.9	(4.0-9.7)	3066
American Indian	25.7	(15.0-36.5)	2,800	6.8	(1.8-11.9)	834
Asian/ Pacific Islander	12.5	(6.5-18.5)	2,227	0.5	(0-1.5)	97
Hispanic	22.6	(13.3-32.0)	4,119	3.3	(0-6.8)	675
Gender						
Female	19.6	(17.6-21.5)	43,026	6.0	(4.7-7.2)	14,195
Male	18.1	(16.2-20.0)	42,157	3.8	(2.7-4.8)	9514
Grade Level						
6th	15.4	(11.4-19.4)	8,599	3.8	(2.3-5.3)	2475
7th	19.0	(15.9-22.2)	11,414	3.9	(2.0-5.8)	2661
8th	19.7	(17.0-22.4)	12,105	6.2	(4.1-8.2)	4188
9th	18.6	(15.8-21.5)	13,522	4.6	(2.1-7.2)	3599
10th	20.8	(15.4-26.2)	14,028	5.6	(3.6-7.7)	3972
11th	21.7	(16.8-26.6)	14,126	5.7	(3.0-8.5)	4006
12th	14.4	(10.2-18.6)	9,740	3.6	(1.3-5.9)	2502
Female Guardian Education						
< High School	36.2	(27.8-44.6)	10,317	6.5	(3.1-9.9)	1998
High School	17.3	(15.4-19.1)	24,619	4.2	(2.5-5.8)	6249
Finished Technical School or Some College	18.7	(15.7-21.8)	16,678	4.5	(2.6-6.3)	4221
College or Advanced Degree	18.4	(15.1-21.7)	25,264	6.0	(4.5-7.6)	8688
Don't Know	15.1	(10.8-19.4)	7,641	3.9	(1.6-6.2)	2162
Male Guardian Education						
< High School	31.6	(25.1-38.1)	12,224	4.5	(1.6-7.4)	1916
High School	16.3	(14.2-18.4)	23,223	4.5	(3.1-5.9)	6756
Finished Technical School or Some College	19.1	(16.7-21.5)	16,744	5.1	(3.3-6.9)	4664
College or Advanced Degree	20.0	(17.0-23.0)	23,851	6.2	(4.2-8.3)	7816
Don't Know	14.4	(10.4-18.3)	9,102	3.8	(1.9-5.7)	2557
Currently Live with a Smoker?						
Yes	22.3	(19.9-24.7)	40,347	5.7	(4.2-7.2)	11,309
No	16.4	(14.4-18.3)	43,839	4.3	(3.1-5.4)	12,007
Days in Room with Someone Smoking in Past 7 days?						
7 days	23.1	(20.1-26.1)	21,024	7.9	(6.0-9.8)	7925
0 days	18.0	(15.6-20.4)	30,213	4.1	(2.8-5.3)	7268
Ever Tried Smoking¶						
Yes	21.8	(19.9-23.7)	40,387	5.3	(3.7-6.9)	10,762
No	16.9	(14.7-19.0)	45,359	4.4	(3.4-5.5)	12,947

*Respondents who answered "yes" to the question, "Have you ever been told by a doctor, nurse or other health professional that you have asthma?"

†Respondents who reported having had an asthma attack in the past 12 months among adolescents who meet the case definition for current asthma

‡95% Confidence Interval: The range within which there is a 95% probability that the true estimate lies

§Estimated number of Wisconsin adolescents calculated using CDC-generated survey weights

¶Respondents who answered "yes" to the question, "Have you ever tried smoking a cigarette, even one or two puffs?"

Table 2. Rates of Tobacco-Related Risk Factor Exposure and School Absenteeism by Lifetime Asthma Diagnosis and Asthma Attack Status, 2004 Wisconsin Youth Tobacco Survey

	Overall Respondents		Lifetime Asthma*				Asthma Attack Past 12 Months†			
			Yes		No		Yes		No	
	%	95% CI‡	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Live with a smoker	41.2	(38.4-44.1)	47.9§	(58.5-64.4)	38.5	(35.6-41.5)	48.5	(38.3-58.7)	43.3	(34.6-52.0)
Smoking allowed or no rules about smoking in the home	38.1	(35.6-4 0.6)	40.1	(35.2-45.0)	35.8	(33.1-38.5)	43.1	(33.6-52.6)	38.2	(29.7-46.7)
Past 7 days in same room with a smoker	20.3	(18.3-22.3)	24.5§	(20.9-28.2)	19.0	(16.8-21.1)	33.4§	(26.1-40.8)	21.8	(16.8-26.8)
Ever tried smoking¶	41.1	(37.1-45.0)	49.9§	(44.0-55.7)	40.8	(36.7-44.9)	47.3	(37.8-56.7)	48.6	(41.2-56.0)
Ever smoked daily#	10.4	(8.3-12.5)	13.0	(9.4-16.6)	9.8	(7.6-12.0)	11.9	(5.8-18.0)	14.6	(9.4-19.8)
Missed ≥3 days of school in past 30 days	17.1	(15.4-18.9)	20.7§	(17.6-23.9)	16.3	(14.5-18.2)	27.5	(25.0-35.0)	19.7	(14.3-25.2)

*Respondents who answered "yes" to the question, "Have you ever been told by a doctor, nurse or other health professional that you have asthma?"
†Respondents who reported having had an asthma attack in the past 12 months among adolescents who meet the case definition for current asthma
‡95% Confidence Interval: The range within which there is a 95% probability that the true estimate lies
§$P<0.05$ based on Wald chi-square test of independence
¶Respondents who answered "yes" to the question, "Have you ever tried smoking a cigarette, even 1 or 2 puffs?"
#Respondents who answered "yes" to the question, "Have you ever smoked cigarettes daily, that is, at least 1 cigarette every day for 30 days?"

Tobacco-Related Risk Factor Exposure and School Absenteeism

Tobacco-Related Risk Factor Exposure—The rates of tobacco-related risk factor exposure among adolescents varied by asthma status. Adolescents who reported having ever been diagnosed with asthma were more likely than adolescents without asthma to report living with a smoker (48% versus 39%), that smoking was allowed in the home or that there were no rules about smoking in the home (40% versus 36%), and spending time on all of the past 7 days in the same room with someone smoking (25% versus 19%). Among adolescents with asthma who reported an asthma attack in the past 12 months, these tobacco-related exposure rates were even higher.

When we examined youth smoking behavior, adolescents ever diagnosed with asthma were statistically more likely to report having tried smoking (50% versus 41%). This phenomenon was only true for males (data not shown). Adolescents who reported an asthma attack in the past 12 months were slightly less likely to report having tried smoking (47%) than adolescents with asthma who did not report an attack (49%), but this rate was still higher than the rate among adolescents never diagnosed with asthma (41%). Rates of ever smoking daily mirrored the patterns of ever trying smoking (Table 2).

School Absenteeism—Adolescents ever diagnosed with asthma reported a statistically significant higher rate of having missed 3 or more days of school in the past 30 days than adolescents never diagnosed with asthma (21% versus 16%). Among adolescents with asthma that reported having an asthma attack in the past 12 months this rate was 28%.

Multivariable Models

To better understand how demographic and tobacco-related risk factors are associated with self-reported asthma diagnosis and asthma attack rates, we used multivariable logistic regression models to consider risk factors simultaneously. The relation between asthma and school absenteeism was also examined.

Risk Factors for Lifetime Asthma Diagnosis

Demographics—African American adolescents had twice the odds of being diagnosed with asthma compared to white adolescents (Table 3). Adjusted odds for other racial/ethnic groups were not significantly different from white adolescents, despite higher prevalence rates among some groups (Table 1).

Adolescents whose female guardian had attained less than a high school education were twice as likely to have been diagnosed with asthma as adolescents whose female guardian had attained a high school education. Adolescents whose male guardian attained an educational level less than high school or had completed education

beyond high school had an increased risk of having ever been diagnosed with asthma compared to adolescents whose male guardian attained a high school education.

Tobacco-Related Risk Factors—Daily ETS exposure was a significant risk factor for asthma when examined without adjusting for other risk factors. When included in a multivariable model, which accounted for living with a smoker, it was no longer significant. Although daily ETS exposure and living with a smoker are highly correlated, living with a smoker is a much stronger predictor of lifetime asthma diagnosis.

When we looked at lifetime asthma diagnosis by gender, we found that the odds varied by adolescent smoking behavior (data not shown). Regardless of their smoking history, females had an increased risk of being diagnosed with asthma compared to males who had never tried smoking. Males who had tried smoking had a higher risk of being diagnosed with asthma compared to males who had never tried smoking and to females overall.

Risk Factors for an Asthma Attack in the Past 12 Months Among Adolescents with Current Asthma

Demographics—Adolescent females with asthma were 1.7 (95% CI: 1.0-2.7) times more likely than males with asthma to report having had an asthma attack in the past 12 months. The interaction between gender and smoking cigarettes found for lifetime asthma diagnosis was not significant for the asthma attack rate.

Tobacco-Related Risk Factors—Adolescents who currently have asthma and are exposed daily to ETS were 2.1 times (95% CI: 1.2-3.5) as likely to have experienced an asthma attack in the past 12 months compared to adolescents with asthma without daily ETS exposure (Table 4). Among adolescents who reported currently having asthma and living with a smoker, those who had an asthma attack in the past 12 months reported a lower percentage of smoking allowed or no rules about smoking in the home. This resulted in a reduced odds ratio (0.9) for having an asthma attack among adolescents living with a smoker and allowing smoking or having no rules about smoking in the home. This interaction term was accounted for in the asthma attack rate model.

Risk Factors for School Absenteeism

Currently having asthma was a significant predictor of school absenteeism despite accounting for several other risk factors in the multivariable model. Current tobacco usage and daily ETS exposure were also significant predictors of school absenteeism. Interactions between having asthma and tobacco exposure were assessed and were not significant.

Table 3. Adjusted Relative Odds of Lifetime Asthma Diagnosis Among Wisconsin Adolescents by Significant Demographic and Tobacco-Related Risk Factors, 2004 Wisconsin Youth Tobacco Survey

	Lifetime Asthma*		
	Adjusted Odds Ratio†	95% CI‡	*P*-value§
Race/Ethnicity			
White	1.0	—	—
African American	1.9	(1.4-2.4)	<0.0001
American Indian	1.5	(0.8-2.8)	0.20
Asian/Pacific Islander	0.7	(0.4-1.3)	0.23
Hispanic	0.8	(0.4-1.6)	0.55
Female Guardian Education			
< High School	2.2	(1.5-3.2)	<0.0001
High School	1.0	—	—
Finished Technical School or Some College	1.1	(0.8-1.4)	0.65
College or Advanced Degree	1.0	(0.8-1.3)	0.95
Don't Know	1.1	(0.6-2.0)	0.85
Male Guardian Education			
< High School	1.7	(1.2-2.4)	0.002
High School	1.0	—	—
Finished Technical School or Some College	1.3	(1.0-1.7)	0.04
College or Advanced Degree	1.5	(1.2-2.0)	0.001
Don't Know	0.9	(0.5-1.5)	0.61
Currently Live with a Smoker?			
No	1.0	—	—
Yes	1.3	(1.1-1.7)	0.01

*Respondents who answered "yes" to the question, "Have you ever been told by a doctor, nurse or other health professional that you have asthma?"
†Relative odds of lifetime asthma diagnosis compared to reference category (odds ratio=1.0), adjusted for all other variables presented in the table and a gender*ever smoked interaction term
‡95% Confidence Interval: The range within which there is a 95% probability that the true estimate lies
§Probability that the null hypothesis (odds ratio=1.0) is rejected

DISCUSSION

Using data from the 2004 WYTS, we found a high prevalence of self-reported asthma among Wisconsin adolescents with almost 1 in 5 students reporting ever being diagnosed with asthma by a health professional. This rate is higher than estimates from statewide surveys where adults report on adolescent asthma, but similar to results of surveys administered to adolescents in other states.[6,7] Some studies have shown that adolescents provide more accurate information about their asthma than their guardians,[8,9] but caution regarding the magnitude of self-reported adolescent asthma prevalence may be warranted.

Asthma attacks are considered preventable through appropriate medical and self-management. Thirty-five

Table 4. Adjusted Relative Odds of School Absenteeism Among Wisconsin Adolescents by Current Asthma Status, Demographics and Tobacco-Related Risk Factors, 2004 Wisconsin Youth Tobacco Survey

	Missed ≥3 Days of School in Past 30 Days		
	Adjusted Odds Ratio*	95% CI†	*P*-value‡
Race/Ethnicity			
White	1.0	—	—
African American	2.2	(1.4-3.4)	0.0007
American Indian	1.6	(0.8-3.0)	0.16
Asian/Pacific Islanders	1.4	(0.9-2.4)	0.15
Hispanic	1.5	(1.0-2.2)	0.05
Grade Level			
6th	1.0	—	—
7th	1.2	(0.8-1.9)	0.46
8th	1.1	(0.7-1.8)	0.65
9th	1.2	(0.8-2.0)	0.39
10th	1.8	(1.1-2.9	0.02
11th	1.9	(1.2-2.9)	0.006
12th	2.5	(1.4-4.3)	0.001
Female Guardian Education			
< High School	0.9	(0.6-1.3)	0.50
High School	1.0	—	—
Finished Technical School or Some College	0.7	(0.5-0.9)	0.01
College or Advanced Degree	0.8	(0.6-1.0)	0.07
Don't Know	0.9	(0.6-1.3)	0.55
Current Asthma			
No	1.0	—	—
Yes	1.4	(1.2-1.8)	0.0008
Daily ETS Exposure			
No	1.0	—	—
Yes	1.4	(1.1-1.8)	0.002
Current Smoker§			
No	1.0	—	—
Yes	2.2	(1.6-2.9)	<0.0001

*Relative odds of missing ≥3 days of school compared to reference category (odds ratio=1.0), adjusted for all other variables presented in the table
†95% Confidence Interval: The range within which there is a 95% probability that the true estimate lies
‡Probability that null hypothesis (odds ratio=1.0) is rejected
§Respondents who answered more than 0 days to the question, "During the past 30 days, on how many days did you smoke cigarettes?"

percent of adolescents who currently had asthma reported having an asthma attack in the past 12 months. This rate indicates room for improvement of asthma management among Wisconsin adolescents.

Consistent with the literature,[3] we found that tobacco smoke exposure is positively associated with lifetime asthma diagnosis. In our analyses, living with a smoker was the strongest tobacco-related risk factor for lifetime asthma diagnosis. Forty-one percent of Wisconsin adolescents reported living with a smoker. Decreasing the proportion of adolescents living with a smoker could reduce the prevalence of asthma.

Adolescent males diagnosed with asthma had a higher rate of ever smoking cigarettes than males never diagnosed with asthma. This is consistent with studies that report higher rates of smoking among children with asthma.[10,11] Adolescents who live with a smoker are more likely to try smoking themselves.[12,13] As adolescents with asthma were more likely to live with a smoker, the increased use of tobacco is not surprising and again points to the importance of decreasing the proportion of adolescents who live with a smoker.

Daily ETS exposure was the most significant predictor of having experienced an asthma attack in the past 12 months. Among adolescents with asthma who had an asthma attack in the past 12 months, 33% spent time daily in the same room as someone smoking. The link between ETS and asthma attacks should be communicated to both adolescents and their guardians.

Public health experts recommend that smoking not be allowed in any part of the home.[14] Sixty-two percent of Wisconsin adolescents reported home smoking rules consistent with this public health message. In homes of adolescents with asthma there was lower compliance with this message. Keeping homes smoke-free should continue to be an important health message to all adults with children living in the home.

School absenteeism is associated with both personal and financial costs. Among 2004 WYTS respondents, students who currently have asthma were more likely to miss 3 or more days of school in the past 30 days. Although associated with missed school days, having an asthma attack in the past 12 months was not a statistically significant predictor of school absenteeism. Insufficient sample size may account for this lack of statistical significance.

As has been well documented in other studies,[15] we found that African Americans and adolescents of low socioeconomic status (as measured by guardian educational level) were more likely to be diagnosed with asthma. When adjusting for other risk factors, these groups did not have an increased asthma attack rate. Adolescent females were more likely to have had an asthma attack in the past 12 months. This is consistent with asthma emergency department and hospitalization rates that are higher for females in this age group.[15]

Although this study provides new insights into asthma among Wisconsin adolescents, because it is a

cross-sectional study, causality of associations cannot be established. All data were self-reported, which could lead to misreporting of asthma status. Although self-report of asthma diagnosis has inherent limitations, the lack of a population-wide asthma registry or similar mechanism to measure asthma prevalence increases reliance on self-reporting. A review of asthma survey questions found that asking about physician-diagnosed asthma, as was done on the WYTS, was the most reliable way to assess self-report of asthma among adults. Asking this question resulted in a mean sensitivity of 68% (range: 48%-100%) and a mean specificity of 94% (range: 78%-100%) when adult self-reported asthma was compared with a clinical diagnosis of asthma.[16] A similar review has not been conducted for adolescents.

In summary, asthma is a disease that continues to affect children into adolescence. Although it is a chronic condition, proper management—including avoidance of triggers—is an essential part of minimizing the disruption the disease can cause to adolescents' lives. Based on the findings of these analyses, it appears that interventions are needed for both adolescents and their guardians to reduce rates of smoking and ETS exposure. The link between asthma and school absenteeism suggests that adolescents with asthma should be better managed to reduce the high costs to individuals and society associated with school absenteeism.

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