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Asthma control in adolescents 10 to 11 y after exposure to the World Trade Center disaster

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BACKGROUND: Little is known about asthma control in adolescents who were exposed to the World Trade Center (WTC) attacks of 11 September 2001 and diagnosed with asthma after 9/11. This report examines asthma and asthma control 10–11 y after 9/11 among exposed adolescents.

METHODS: The WTC Health Registry adolescent Wave 3 survey (2011–2012) collected data on asthma diagnosed by a physician after 11 September 2001, extent of asthma control based on modified National Asthma Education and Prevention Program criteria, probable mental health conditions, and behavior problems. Parents reported healthcare needs and 9/11-exposures. Logistic regression was used to evaluate associations between asthma and level of asthma control and 9/11-exposure, mental health and behavioral problems, and unmet healthcare needs.

RESULTS: Poorly/very poorly controlled asthma was significantly associated with a household income of \leq \$75,000 (adjusted odds ratio (AOR): 3.0; 95% confidence interval (CI): 1.1–8.8), having unmet healthcare needs (AOR: 6.2; 95% CI: 1.4–27.1), and screening positive for at least one mental health condition (AOR: 5.0; 95% CI: 1.4–17.7), but not with behavioral problems. The impact of having at least one mental health condition on the level of asthma control was substantially greater in females than in males.

CONCLUSIONS: Comprehensive care of post-9/11 asthma in adolescents should include management of mental health-related comorbidities.

The collapse and burning of the World Trade Center (WTC) towers on 11 September 2001 (9/11) exposed hundreds of thousands of people to a complex mixture of dust, debris, and jet fuel combustion byproducts (1). It is estimated that over 25,000 persons in lower Manhattan developed asthma symptoms after exposure to the WTC terrorist attacks and the subsequent rescue and recovery efforts (1). In the years immediately following 9/11, new-onset asthma rates were elevated among exposed adults and many of those affected continued to experience respiratory symptoms (i.e., coughing, shortness of breath) years later (1,2).

An estimated 25,000 children were living or attending school in lower Manhattan near the WTC on 9/11, and potentially were in the path of the dust cloud of building debris and smoke after the collapse of the towers, as well as for several months following the attacks, and could have inhaled particulate matter and toxic substances (3,4). Associations between 9/11-related exposures and both asthma diagnosis and persistent respiratory symptoms among children and adolescents have been documented (4–6). A previous report found that 2 to 3 y after 9/11, over half of children under 18 y of age who were enrolled in the World Trade Center Health Registry (Registry) reported new or worsening respiratory symptoms (53%), and 5.7% reported a post-9/11 diagnosis of asthma, both of which were associated with exposure to the dust cloud that resulted from the collapse of buildings on 9/11 (4). A subsequent study of Registry enrollees under 18 y old found that respiratory symptoms persisted up to 7 y post-9/11 (5). The WTC Environmental Health Center which collected clinical data on a sample of children an average of 7.8 y after 9/11, reported new onset provider-diagnosed asthma in 21.4% of children, and found that dust cloud exposure was associated with pulmonary function abnormalities, such as isolated low forced vital capacity pattern and an obstructive pattern consistent with asthma (6).

Although the association between asthma and 9/11-exposure in children and adolescents has been documented, little is known about asthma control in this population. Large population-based surveys consistently show that poor asthma control is common in many children with asthma (7,8). Asthma control is affected by many factors, including healthcare access (9,10), socioeconomic status (9,10), and comorbid mental health conditions (11–13).

It has been observed that adolescents with symptomatic asthma are more likely than adolescents without asthma to have lower perceived well-being, more negative behaviors, and a greater number of physical and mental health comorbidities (14). Several studies found that depression has been associated with uncontrolled asthma (11,12). In adults with 9/11-related asthma, having at least one mental health condition has been

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associated with poorly controlled asthma (15). However, little is known about the association between mental health conditions and the level of asthma control especially among 9/11-exposed adolescents.

Previous studies of adult Registry enrollees found that those with unmet healthcare needs are more likely to have severe mental health symptoms, comorbid mental and physical health problems, and have lower quality of life (1,16). Unmet healthcare needs among adolescents have been shown to be associated with poorer health status and functioning, including asthma control (17). Poorly controlled asthma has also been associated with unmet healthcare needs related to cost or access barriers (18), such as an inability to pay for asthma medications and not having access to asthma specialists (19).

The goal of this study was to evaluate asthma control 10–11 y after 9/11 among Registry as children, and to determine whether poor asthma control is associated with specific factors including adolescent 9/11-exposure, adverse mental health, behavior problems, and unmet healthcare needs.

RESULTS

The study population was evenly split between males and females, 39.0% were 5–8 y old on 9/11, 54.3% were white, and approximately one-third (36.6%) reported a household income of \$75,000 or less in 2010 (Table 1). Parents of 17 adolescents (4.4%) reported unmet healthcare needs for the child. Over half of parents reported their adolescent had witnessed one or more disturbing events on 9/11 (57.9%), 42.4% were reported to be in the dust cloud, 5.6% had sustained an injury, and 34.4% had a family exposure. Forty-eight adolescents (12.4%) had an abnormal/borderline Strengths and Difficulties Questionnaire (SDQ) score, and 14.5% screened positive for at least one mental health condition at Wave 3 (3.3% Post-traumatic Stress Disorder (PTSD); 6.9% depression; and 11.0% agoraphobia).

Prevalence of post-9/11 physician diagnosed asthma among adolescents is shown in Table 1, within each category of demographic and exposure variables. The overall prevalence was 25.5%, and was significantly greater in males (31.6%) than in females (19.6%; $P = 0.01$). Asthma prevalence did not differ significantly with age group, but was higher in African American (63.6%), Hispanic (39.0%), and Asian/other (24.1%) than in Caucasian adolescents (19.7%). Asthma was also significantly higher in adolescents from households with a 2010 income of \leq \$75,000 and those with parent report of unmet healthcare needs. Among the four 9/11-exposures measured, only dust cloud exposure was associated with asthma ($P = 0.001$).

Among the 100 adolescents with asthma, 23% had poorly/very poorly controlled asthma (Table 2). Adolescents from households reporting a 2010 income of \leq \$75,000 had a higher proportion of poorly/very poorly controlled asthma (34.1%) compared to adolescents from households with income greater than \$75,000 (15.7%; $P = 0.04$). A significantly higher proportion of adolescents with unmet healthcare needs had poorly/very poorly controlled asthma (55.6%) when compared to those adolescents with no unmet healthcare needs (20.0%;

$P = 0.02$). None of the 9/11-exposures or SDQ scores were associated with asthma control. Adolescents who screened positive for at least one mental health condition were more likely to have poorly/very poorly controlled asthma (50.0%) than adolescents with no mental health condition (19.3%; $P = 0.02$) (Table 2).

Consistent with the definition of asthma control used in this analysis, most participants who were categorized as having poorly/very poorly controlled asthma reported wheezing or whistling in chest and sleep disturbances because of wheezing or whistling in the past 12 mo (Table 3). A similar trend was observed with reported asthma attacks; 69.6% of participants with poorly/very poorly controlled asthma reported having had at least one asthma attack during the past year, compared to 42.9% of those with controlled asthma ($P = 0.004$). Emergency room visits and hospitalizations for asthma within the preceding year were also much more common among those with poorly/very poorly controlled asthma (Table 3).

After adjusting for age, race/ethnicity, gender, and dust cloud exposure, adolescents with asthma whose parents reported unmet healthcare needs were five times more likely to have poorly/very poorly controlled asthma (adjusted odds ratio (AOR): 5.2; 95% confidence interval (CI): 1.2–22.9) compared to adolescents whose parents reported no unmet healthcare needs. In both the unadjusted and adjusted analysis, adolescents from households with an income of \leq \$75,000 were almost three times more likely to have poorly/very poorly controlled asthma (AOR: 2.9; 95% CI: 1.1–8.2). Adolescents who screened positive for at least one mental health condition were six times more likely to have poorly/very poorly controlled asthma (AOR: 6.1; 95% CI: 1.5–24.7) (Table 4). We further investigated the increase seen in the AOR of mental health conditions predicting asthma control. After stratifying by gender, the presence of at least one mental health condition had a higher point estimate of association with lack of asthma control among females (AOR: 9.1; 95% CI: 1.4–61.5) than males (AOR: 3.4; 95% CI: 0.4–28.7) (data not shown).

DISCUSSION

Ten years after the 9/11 WTC terrorist attacks, among adolescent Registry enrollees who responded to the Wave 3 survey and reported post-9/11 physician diagnosed asthma, almost one-fourth had poorly or very poorly controlled asthma. We found adolescents from lower income households had poorer asthma control compared with adolescents from higher income households, similar to other reports (9,10). Comorbid mental health conditions were also strongly associated with poor control. In addition, there was an association between poorly/very poorly controlled asthma and the adolescent having unmet healthcare needs.

Asthma control associated with screening positive for at least one mental health condition, consistent with adult 9/11 studies and non-9/11 related studies of children (11,12,15). Psychological comorbidity among 9/11-exposed adolescents with asthma may present particular challenges for asthma management. Comorbid anxiety or depressive disorders in

Table 1. Prevalence of asthma and selected demographic characteristics, 9/11 exposures, and mental health screening measures

	No. adolescents	%	Physician diagnosed asthma ^a	%*	P value
Total	392	100	100	25.5	---
Demographic					
Gender					
Male	193	49.2	61	31.6	0.01
Female	199	50.8	39	19.6	
Age on 9/11 (years at W3)					
< 2 (10–11)	93	23.7	25	26.9	NS
2 to < 5 (12–14)	146	37.2	32	21.9	
5 to 8 (15–19)	153	39.0	43	28.1	
Race/ethnicity					
White	213	54.3	42	19.7	<0.0001
African American	22	5.6	14	63.6	
Hispanic	41	10.5	16	39.0	
Asian/Multiracial/Other	116	29.6	28	24.1	
Household income (2010)					
≤ \$75,000	136	36.6	44	32.4	0.02
> \$75,000	236	63.4	51	21.6	
Unmet healthcare needs					
Yes	17	4.4	9	52.9	0.01
No	367	95.6	90	24.5	
9/11 Exposures ^b					
Dust cloud exposure					
Yes	166	42.4	57	34.3	0.001
No	221	57.6	43	19.5	
Witnessed ≥1 disturbing events					
Yes	227	57.9	60	26.4	NS
No	165	42.1	40	24.2	
Sustained injury					
Yes	22	5.6	7	31.8	NS
No	370	94.4	93	25.1	
Family exposure					
Yes	135	34.4	37	27.4	NS
No	257	65.6	63	24.5	
Behavioral screening measure					
Strengths and Difficulties Questionnaire					
Abnormal/borderline	48	12.4	16	33.3	NS
Normal	338	87.6	82	24.3	
Mental health screening measure					
At least one mental health condition ^c					
Yes	57	14.5	19	33.3	NS
No	335	85.5	81	24.2	

^aConsensus reporting by parent and adolescent. ^bParent reported at Wave 1. ^cScreen positive for probable PTSD, major depressive disorder, or agoraphobia. *Row percent; NS, not significant.

Table 2. Characteristics of adolescent enrollees with self-reported physician diagnosis of asthma according to level of control

	Controlled	% ^c	Poorly/very poorly controlled	% ^c	P value
Total	77	77.0	23	23.0	---
Demographic					
Gender					
Male	45	74.8	16	26.2	NS
Female	32	82.0	7	17.9	
Age on 9/11					
< 2 (10–11)	16	64.0	9	36.0	NS
2 to < 5 (12–14)	27	84.4	5	15.6	
5 to 8 (15–19)	34	79.1	9	20.9	
Race/ethnicity					
White	35	83.3	7	16.7	NS
African American	7	50.0	7	50.0	
Hispanic	13	81.3	3	18.7	
Asian/multiracial/other	22	78.6	6	21.4	
Household income (2010)					
≤ \$75,000	29	65.9	15	34.1	0.04
> \$75,000	43	84.3	8	15.7	
Unmet healthcare needs					
Yes	4	44.4	5	55.6	0.02
No	72	80.0	18	20.0	
9/11 exposures ^a					
Dust cloud exposure					
Yes	43	75.4	14	24.6	NS
No	34	79.1	9	20.9	
Witnessed disturbing events					
Yes	47	78.3	13	21.7	NS
No	30	75.0	10	25.0	
Sustained injury					
Yes	5	71.4	2	28.6	NS
No	72	77.4	21	22.6	
Family exposure					
Yes	29	78.4	8	21.6	NS
No	48	76.2	15	23.8	
Behavioral screening measure					
Strengths and Difficulties Questionnaire					
Abnormal/borderline	11	68.7	5	31.3	NS
Normal	65	79.3	17	20.7	
Mental health screening measure					
At least one mental health condition ^b					
Yes	6	50.0	6	50.0	0.02
No	71	80.7	17	19.3	

^aParent reported at Wave 1. ^bScreen positive for probable PTSD, major depressive disorder, or agoraphobia. ^cRow percent; NS, not significant.

adolescents with asthma might have a significant impact on their ability to cope effectively with their asthma (11,12). Although the explanation for this relationship is unclear, it is conceivable that respiratory symptoms trigger or increase

psychological distress, or that mental health symptoms worsen respiratory symptoms directly. Another possible mechanism is that mental health symptoms interfere with adherence to medical treatment for respiratory symptoms. Studies have shown

that adherence declines further in patients with asthma who are depressed (20,21). Our findings underscore the importance of integrating physical and psychological health care services for all adolescents; particularly those directly exposed to 9/11, and could be applicable to adolescents exposed to other disasters as well. One potential way to assist parents of adolescents with asthma could be in school-based programs. Where possible, schools should implement strategies similar to those recommended by the Centers for Disease Control and Prevention to address asthma, which include provision of appropriate mental health services among other components of a coordinated school health program for students with asthma (22).

We found that the associations between having at least one mental health condition and poorly/very poorly controlled asthma differed between males and females. Studies examining adherence in the pediatric population have found no relationship between adherence and gender (23,24), although most studies did not account for the presence or absence of comorbid mental health condition. It is possible that a mental health condition in an adolescent girl has a more pronounced disabling effect than in a boy, increasing the likelihood of asthma control problems. Similar to other studies, we did find a higher proportion of females with at least one mental health issue compared to males (25,26). Studies of adolescents with cystic fibrosis found that females are more likely to have serious respiratory infections and shorter life expectancy, and that female patients are more likely to have mental health problems (27,28). Additionally, some studies have found that adolescent females report more physical health symptoms, psychological symptoms and use more emotion-oriented and problem-oriented coping strategies than adolescent males (29). Because coping styles may be associated with medication adherence; gender differences and coping skills need to be considered when assessing poorly controlled asthma.

A frequent correlate of low income is unmet healthcare needs. We found that adolescents with asthma whose parents reported unmet healthcare needs were five times more likely to have poorly/very poorly asthma compared to those adolescents without unmet healthcare needs. This group with unmet healthcare needs is at significant risk for worsening symptoms and greater morbidity, and untreated health problems put children at risk for developing lifelong chronic conditions (17). Factors related to low income are only one potential explanation for unmet healthcare needs; others include parent mental health and demographic factors such as parent education (30). Additional outreach may be needed to educate parents on the WTC Health Program for responders and non-responder survivors as part of the federally funded James Zadroga Health and Compensation Act of 2010, which also includes a nationwide network of providers for affected persons living outside the New York City area (31). For an adolescent with persistent asthma to receive appropriate care, several steps must occur. Asthma care is complex, from symptom presentation and recognition to medication adherence, and a failure at any step could lead to poor control. Unmet adolescent healthcare needs may result from parental attitudes and concerns about

Table 3. Prevalence of respiratory symptoms and healthcare seeking among adolescents with asthma

	Controlled N = 77 (%)	Poorly/very poorly controlled N = 23 (%)	P value
Symptoms, past 12 mo ^a			
Wheezing or whistling in chest	50.6	82.6	0.02
Sleep disturbed because of wheezing or whistling ^b	20.8	78.3	<0.0001
Events and care seeking, past 12 mo ^c			
One or more asthma attacks	42.9	69.6	0.004
One or more asthma-related ER visits	7.8	17.4	NS

^aAdolescent report. ^bLess than one night/week or one or more nights/week. ^cParent report; NS, not significant.

Table 4. Association of poorly/very poorly controlled asthma with selected demographic characteristics and mental health screening measures among 100 adolescent with diagnosed asthma

Model		COR (95% CI)	AOR ^b (95% CI)
1	Household income (2010)		
	≤ \$75,000	2.8 (1.1–7.4)	2.9 (1.1–8.2)
	>\$75,000	Ref.	Ref.
2	Unmet healthcare needs		
	Yes	5.0 (1.2–20.5)	5.2 (1.2–22.9)
	No	Ref.	Ref.
3	At least one mental health condition ^a		
	Yes	4.2 (1.2–14.6)	6.1 (1.5–24.7)
	No	Ref.	Ref.

^aScreen positive for probable PTSD, major depressive disorder, or agoraphobia.

^bEach model adjusted for age, race/ethnicity, gender, and dust cloud exposure.

appropriate administration of asthma medicines and how to manage acute asthma attacks, which have been associated with the frequency of urgent care visits (a measure for uncontrolled asthma) for childhood asthma (32,33). Improved control could also generate substantial healthcare savings if asthma-related emergency room visits and hospitalizations, which were relatively common among participants with poorly/very poorly-controlled asthma, were prevented.

Limitations

Our data are limited by their self-reported nature; further, the low response rates to the adolescent and parent surveys and resulting small sample size reduced the power of our analyses and precision of our effect estimates. Low response rates are a constant challenge in adolescent focused studies, and our response rate is comparable to that of other studies among adolescents (34–36). A response bias may be present; while there was no significant difference in report of post-9/11 asthma at Wave 1 between those who completed Wave 3 and those who

did not; parents and adolescents who did not complete Wave 3 were more likely to be non-white and to have lower household income. The accurate assessment of exposure-outcomes relationships is a critical challenge in 9/11-exposed populations. Because the event was a disaster with few immediate studies and exposure assessments, personal exposure cannot be reconstructed completely.

Conclusions

Almost a quarter of adolescents with asthma had poorly or very poorly controlled asthma 10–11 y after 9/11. There were associations between unmet healthcare needs and comorbid mental health conditions and asthma control. These findings suggest that providers who care for adolescents with symptoms of post-9/11 asthma should be aware that asthma control may be particularly difficult to achieve if mental health symptoms are present, and that integration of mental and physical healthcare is crucial for adolescents affected by the 9/11 or other natural or manmade disasters.

METHODS

Study Population

Study subjects were drawn from the Registry, a longitudinal cohort of 71,431 rescue and recovery workers, lower Manhattan residents living south of Canal Street, students attending schools south of Canal Street, building occupants, and passersby south of Chambers Street on 11 September 2001 (1). Three Waves of data were gathered: baseline (Wave 1, 2003–2004), Wave 2 (2006–07), and Wave 3 (2011–12). The present analysis is based on pediatric data obtained at Waves 1 and 3. At Wave 1, parents completed questionnaires on behalf of 3,184 children under age 18, providing information about the child’s health and 9/11-exposure. At Wave 3, parents of adolescent enrollees age 10 to 17 completed an “adult” Wave 3 questionnaire that provided information about their own emotional health as well as data on household income and the adolescent’s physical health and 9/11-exposures, while the adolescents completed a separate questionnaire about their behavior and physical and mental health to be returned in a separate envelope for confidentiality. Multiple rounds of personalized paper survey mailings, monthly email and postcard reminders, and door-to-door home outreach visits were conducted to increase the response. Of the 1,341 adolescents still under 18 y of age at the time of the Wave 3 survey, a total of 491 (36%) adolescent surveys and 559 (42%) parent surveys were returned. Adolescent enrollees who did not complete Wave 3 were similar to those who did with regard to age, gender, parent education, post-9/11 asthma, and all 9/11-exposures but were more likely to be African American or Hispanic, or have parents who reported a 2002 income of less than \$50,000. Adolescent enrollees missing information on asthma (*n* = 80) and those missing a corresponding parent survey (*n* = 19) were excluded. This resulted in a final analytic sample of 392. The Registry protocol was approved by the institutional review boards of the Centers for Disease Control and Prevention and NYC Department of Health and Mental Hygiene.

Outcome Variable

The outcome of interest was asthma control among adolescents with asthma diagnosed after 11 September 2001. Asthma diagnosis was assessed at Wave 3 and defined as both parent and adolescent reporting that a physician (or other health professional) had told them the adolescent had asthma after 11 September 2001. Only those instances where both adolescent and parent reported this diagnosis were considered to have the outcome. We categorized study participants as having controlled, poorly, or very poorly controlled asthma based on modified criteria from the National Asthma Education and Prevention Program’s Third Expert Panel Report (37) (Table 5), which has been used in a previous Registry study on asthma control in adults (15). Participants were assigned to the most severe category

in which any component was reported. For analysis, the poorly and very poorly controlled were collapsed into one category because of the small numbers in those categories.

Independent Variables

Unmet healthcare needs. At Wave 3, parents were asked: “During the last 12 months, was there ever a time when your adolescent needed health care for physical health problems, but did not receive it?”; a “yes” response indicated unmet healthcare needs. A similar question has been used to assess unmet mental healthcare needs among adults in the Registry and elsewhere (18,38).

Adolescent 9/11-exposure. For consistency purposes, measures of adolescent 9/11-exposures used in this study have been previously used by Hoven et al.(39) and the Registry in studies on the effects of 9/11-exposure on the mental and physical health of children (4,5,40). Adolescent 9/11-exposures assessed included: (i) witnessing one or more disturbing events during and/or after the WTC attacks (airplane crashing into a tower, buildings collapsing, people running away from a cloud of smoke, or people being injured, killed, falling, or jumping from one of the towers), (ii) sustaining an injury as a result of the attacks (burn, broken bone, concussion, cut, sprain, or other injury), (iii) being caught in the dust cloud that resulted from the collapse of the WTC towers, or (iv) family exposure (having a family member (mother, father, sibling, grandparent, or any other family member) who was injured or killed in the attacks, or was in the WTC attack area and escaped unhurt). The first three exposure items were derived from the Wave 1 questionnaire; the fourth (family exposure) was derived from the Wave 3 parent questionnaire.

Adolescent behavior problems. Behavioral difficulties among adolescents were assessed at Wave 3 using the adolescent-reported SDQ. The SDQ is a 25-question, validated, behavioral screening questionnaire that incorporates scales for conduct problems, hyperactivity, emotional symptoms, peer problems, and pro-social behavior (41,42). We summed items in the first four scales to arrive at a total score (0–40) that is interpreted as a measure of emotional distress (41–43). Due to small numbers, we dichotomized this SDQ score into normal (0–15) and abnormal/borderline (16–40) similar to other studies (40,43).

Adolescent mental health outcomes. Probable PTSD, depression, and agoraphobia were assessed on the Wave 3 adolescent survey using the Diagnostic Interview Schedule for Children (DISC) Predictive Scales (DPS), as used in previous WTC publications on children (5,39). The assessment includes seven questions evaluating stress-related functioning during the past 4 wk; a scoring algorithm was used to determine “impaired functioning” (39). The assessment also includes eight symptom questions to evaluate stress referencing 9/11-disaster related experiences. Probable PTSD was assumed if adolescents scored in the impaired functioning range, and

Table 5. Definition of asthma control (based on National Asthma Education and Prevention Program, Third Expert Panel on the Diagnosis and Management of Asthma, EPR 3)

Component of control	Controlled ^a	Poorly controlled ^a	Very poorly controlled ^a
Shortness of breath, wheezing, and/or cough	≤ 2 d/week	3–6 d/week	Daily
Nighttime awakenings	≤ 2x/month	1–3x/ week	≥ 4x/week
Interference with normal activity ^b	None/a little of the time	Some/most of the time	All of the time
Use of a rescue inhaler or nebulizer ^c	< 3x/week	1–2x/day	> 2x/day

^aParticipants were assigned to the most severe category in which any component was reported. ^bThis differs slightly from the EPR 3 definition, which specifies no interference with normal activity for well-controlled, some limitation for poorly-controlled, and extreme limitation for very poorly-controlled asthma. ^cThis differs slightly from the EPR 3 definition, which specifies inhaler use ≤ 2 d/week for well-controlled, > 2 d a week for poorly-controlled, and several times per day for very poorly-controlled asthma. Data taken from refs. (15,37).

answered “yes” to at least five of the eight symptom questions suggesting re-experiencing, avoidance, or sense of a foreshortened future. Probable depression was measured using a nine-item scale from the DPS. Criteria for probable depression included a positive response to seven or more items and impaired function (39). Probable agoraphobia was measured using a six-item scale and criteria for probable agoraphobia were a positive response to three or more items and impaired functioning (39). Adolescents who screened positive for at least one of the three mental health conditions were compared with adolescents who screened negative for all three due to small numbers.

Additional Variables

Asthma-related events and asthma-related healthcare seeking. At Wave 3, parents were asked in the last 12 mo if their adolescent had an episode of asthma or an asthma attack and how many times did their adolescent go to an emergency room or urgent care center because of asthma.

Respiratory symptoms. At Wave 3, adolescents were asked if they had wheezing or whistling in their chest in the last 12 mo and, if in the last 12 mo, how often has their sleep been disturbed due to wheezing or whistling (“never”, “less than one night per week”, or “one or more nights per week”).

Statistical Analysis

The prevalence of asthma was calculated by demographic characteristics, 9/11-exposures, and mental health screening measures. The asthma control analysis was restricted to adolescents with asthma. A chi-squared test was used to compare level of asthma control for demographic characteristics, unmet healthcare needs, behavioral and mental health outcomes, and 9/11-exposures. Using logistic regression, adjusted odds ratios were calculated to estimate the strength of association between asthma control and those variables that were significant in the bivariate analysis at $P \leq 0.05$. Based on preliminary analyses, adjustment variables were: age, gender, race/ethnicity, and being caught in the dust cloud on 9/11. All analyses were conducted using SAS Version 9.2 (Cary, NC).

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