

# Abuse during childhood and adolescence and risk of adult-onset asthma in African American women

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**Background:** Experiences of violence contribute to the occurrence of childhood asthma, but there is little information on the effect of early-life abuse on adult-onset asthma.

**Objective:** We prospectively assessed the relation between physical and sexual abuse during childhood and adolescence and the incidence of adult-onset asthma in the Black Women's Health Study.

**Methods:** We followed 28,456 women from 1995 through 2011 with biennial mailed questionnaires. Experiences of physical and sexual abuse that occurred during childhood and adolescence were obtained in 2005. Cox regression models were used to estimate incidence rate ratios (IRRs) and 95% CIs.

**Results:** During 417,931 person-years of follow-up, 1,160 participants reported physician-diagnosed asthma and concurrent use of asthma medication. Compared with women who experienced no abuse during childhood or adolescence, the multivariable IRR for any childhood abuse was 1.24 (95% CI, 1.06-1.45), and for any adolescent abuse, it was 1.10 (95% CI, 0.88-1.36). The IRR was higher for childhood physical abuse (IRR, 1.29; 95% CI, 1.07-1.49) than for childhood sexual abuse (IRR, 1.15; 95% CI, 0.88-1.49). IRRs for physical and sexual abuse during adolescence were compatible with 1.0. The association between childhood abuse and asthma incidence was stronger in older compared with younger women.

**Conclusion:** In this large cohort of African American women, there was a positive association between adult-onset asthma and childhood physical abuse and weaker associations for childhood sexual abuse and any abuse during adolescence. Given the high prevalence of asthma and childhood abuse, this association is of public health importance. (*J Allergy Clin Immunol* 2013;131:1058-63.)

**Key words:** Asthma, child abuse, adolescent abuse, incidence, longitudinal studies, cohort studies, African Americans, women

The high and increasing prevalence of asthma in the United States (8% of the population in 2009<sup>1</sup>) poses enormous burdens to

## Abbreviations used

BMI: Body mass index  
BWHS: Black Women's Health Study  
CES-D: Center for Epidemiological Studies–Depression  
IRR: Incidence rate ratio

the affected patients and to society.<sup>2</sup> African American women have asthma disproportionately. In the 2001-2003 National Health Interview Survey data, the average annual prevalence was 9.5% among black women compared with 8.4% among white women.<sup>3</sup> The average annual rate of death from asthma among adult asthmatic patients was 4.6 per 10,000 among black women and 2.7 per 10,000 among white women.<sup>3</sup>

The prevalence of childhood and adolescent abuse has been reported to be twice as high among black as white children.<sup>4</sup> Cross-sectional studies show that the prevalence and severity of childhood asthma are associated with experiences of violence.<sup>5-7</sup> In addition, 2 prospective studies suggest that exposure to violence can increase asthma incidence in children.<sup>8,9</sup> However, there is little information on the effect of childhood abuse on adult-onset asthma. A meta-analysis indicated that respiratory problems are more common among adults who experienced abuse as children,<sup>10</sup> but most studies have been small and cross-sectional and have grouped respiratory problems together. In 2 studies that assessed asthma specifically, both prevalence<sup>11</sup> and incidence<sup>12</sup> were twice as high in subjects who reported childhood abuse as in those who did not. The hypothesized mechanism linking abuse to asthma incidence is stress and its physiologic consequences, particularly effects on the immune system.<sup>6,13,14</sup>

To determine whether physical or sexual abuse during childhood or adolescence is associated with increased risk of adult-onset asthma, we conducted a prospective analysis of abuse during childhood and adolescence in relation to the incidence of adult-onset asthma in the Black Women's Health Study (BWHS), a large cohort study of African American women who have been followed for more than 15 years.

## METHODS

### Study population

The BWHS is a prospective cohort study established in 1995, when 59,000 African American women aged 21 through 69 years were recruited mainly from subscribers to *Essence* magazine, a general readership magazine targeted to black women.<sup>15</sup> The baseline questionnaire elicited information on demographic and lifestyle factors, reproductive history, and medical conditions. The cohort is followed biennially by using mailed and Web-based health questionnaires. Follow-up has averaged more than 80% of the original cohort through 7 questionnaire cycles. The study protocol was approved by the Institutional Review Board of Boston University.

This analysis uses data from the baseline questionnaire and 8 subsequent follow-up cycles (1995-2011). The 2005 questionnaire elicited information

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on abuse experienced during childhood, adolescence, and adulthood. We excluded women who did not complete the 2005 questionnaire ( $n = 15,826$ ) or answer any of the questions about abuse ( $n = 8,412$ ), reported prevalent asthma ( $n = 3,347$ ), or lung cancer ( $n = 18$ ) at baseline or reported asthma during childhood ( $n = 749$ ).

## Diagnosis of asthma

On all questionnaires from 1997 through 2011, participants were asked whether they had been given a diagnosis of asthma in the previous 2-year interval, the year in which they had first received a diagnosis, and whether they used “inhalers or pills” for asthma at least 3 days per week. Cases were defined as women who reported an initial physician’s diagnosis of asthma after 1995 together with concurrent use of asthma medication. We excluded women who reported incident asthma but did not report concurrent asthma medication use ( $n = 1,208$ ) and women who reported asthma medication use but no diagnosis of asthma ( $n = 985$ ). After exclusions, 28,456 women remained.

## Ascertainment of abuse

On the 2005 questionnaire, participants were asked multiple questions about experiences of abuse that occurred “as a child (up to age 11),” “as a teenager (age 12-18),” and “as an adult (age 19 to present).” The 9-item abuse assessment instrument was adapted from the Conflict Tactics Scales<sup>16</sup> and the Pregnancy Abuse Assessment Screen.<sup>17</sup> Response categories were never, 1 to 3 times, and 4 or more times. Methods for creating the summary abuse variables have been described elsewhere.<sup>18</sup> In brief, a physical abuse summary score was created to indicate the frequency of occurrence of nonsexual abuse (eg, someone “pushed, grabbed, or shoved me” or “kicked, bit, or punched me”); the resulting score ranged from 0 to 9 and was categorized as low (score = 1), intermediate (score = 2), or high (score  $\geq 3$ ). A sexual abuse summary score was created from 2 questions that ascertained sexual abuse (ie, someone has “been sexual with me against my will” or “exposed genitals against my will”) with categories of never, 1 to 3 incidents, and 4 or more incidents. Participants were also asked how often they felt in danger in the home “physically or sexually” separately as a child and as a teenager (never, 1-3 times, and  $\geq 4$  times).

## Ascertainment of covariates

Data on weight and height were obtained in 1995, and weight was updated on each subsequent follow-up questionnaire. Data on smoking history were obtained in 1995, and smoking status and amount smoked were updated on each follow-up questionnaire. Alcohol consumption, hours per week spent in vigorous physical activity, parity, menopausal status, and use of menopausal female hormones were ascertained in 1995 and updated every questionnaire cycle. In 1997, respondents were asked about exposure to secondhand tobacco smoke at home at ages 0 to 10, 11 to 20, 21 to 30, and 31 to 40 years and currently; they were asked for exposure at the office for ages 21 years and older. Exposure was defined as being “in the same room with a smoker for at least an hour a day for 12 consecutive months or more.” Information was also obtained on history of asthma in either parent and whether the participant had health insurance and a regular doctor (obtained in 1997), household income and number of persons supported by the income (obtained in 2003), marital status (updated in 2005), and whether the participant’s mother smoked when pregnant with her (obtained in 2009).

## Statistical analysis

We used Cox proportional hazards regression models to estimate incidence rate ratios (IRRs; synonymous with the relative risk) and 95% CIs for the association between abuse victimization and incident asthma. The reference category for all analyses was women who reported no abuse during childhood or adolescence. The basic model was adjusted for age and calendar time. Separate variables for physical and sexual abuse during childhood and adolescence were included simultaneously in the basic model. We then added potential confounders: parental history of asthma, body mass index (BMI;

weight in kilograms divided by height in meters squared), hours per week of vigorous physical activity, menopausal female hormone use, household income, number of persons supported by the income, education, exposure to secondhand smoke, current smoking, pack years of smoking, and alcohol consumption. Indicator variables were used to model missing covariate data. The following variables did not materially change the results and therefore were not included in the final model: having access to health insurance, having a regular doctor, marital status, height, and whether the participant’s mother smoked when pregnant with her.

In a separate model we assessed the effect of 4 covariates that can mediate the relation between childhood or adolescent abuse and asthma incidence because they might be consequences of early abuse and in the pathway linking abuse and asthma: adult abuse and scores on the depression, stress, and coping scales. The 2005 questionnaire included scales that assessed symptoms of depression (Center for Epidemiological Studies–Depression [CES-D] scale<sup>19</sup>), symptoms of stress (a short form of the Perceived Stress Scale<sup>20</sup>), and coping skills (a short form of the Brief COPE scale<sup>21</sup>). For each scale, a simple composite score was created by summing the items.

We conducted analyses stratified by age, BMI, smoking status, adult abuse, and scores on the CES-D, stress, and coping scales. We tested for statistical interaction with the likelihood ratio test, comparing models with and without interaction terms. Analyses were conducted with SAS statistical software version 9.3 (SAS Institute, Cary, NC).

## RESULTS

During 16 years of follow-up comprising 417,931 person-years, 1,160 women reported incident adult-onset asthma together with asthma medication use. The mean age at diagnosis was 47 years (SD, 11 years; range, 23-82 years).

Compared with women who were not abused during childhood or adolescence, abused women were younger, more likely to be current drinkers, more likely to have been exposed to secondhand smoke, and more likely to have reported more pack years of smoking, a higher prevalence of adult abuse, and more symptoms of depression and stress (Table I).

IRRs for asthma were increased among women who reported childhood abuse (Table II), with a multivariable IRR for any childhood abuse of 1.24 (95% CI, 1.06-1.45). The multivariable IRR for childhood physical abuse only was 1.26 (95% CI, 1.07-1.49), and it was 1.15 (95% CI, 0.88-1.49) for childhood sexual abuse only. All IRRs for adolescent abuse were consistent with 1.0.

Adding the potential mediators to the multivariable model did not materially change the IRRs for childhood physical abuse (data not shown). For example, the IRR for the highest category of frequency of childhood physical abuse decreased from 1.35 (95% CI, 1.08-1.69) to 1.28 (95% CI, 1.02-1.61) when terms for adult abuse and scores on the stress, coping, and CES-D scales were added.

IRRs for women who felt in danger in the home in addition to being abused as children (38% of those reporting child abuse) were higher than those for women who were abused but did not feel in danger (Table III). For example, the IRR was 1.53 (95% CI, 1.15-2.03) for the highest frequency of physical abuse among women who felt in danger and 1.26 (95% CI, 0.97-1.64) among women who did not feel in danger in the home.

The IRRs for child abuse were higher in women who were aged 40 years and older at baseline compared with those among women younger than 40 years of age (Table IV). The IRR for any child abuse was 1.43 (95% CI, 1.14-1.78) among older women compared with 1.07 (0.85-1.33) among younger women ( $P$  for interaction = .02); the IRR in the highest category of frequency of physical abuse was 1.54 (95% CI, 1.11-2.14) in the older women and 1.18 (95% CI, 0.86-1.62) in the younger women

**TABLE I.** Selected baseline characteristics of 28,456 BWHS participants according to abuse victimization reported during childhood and adolescence\*†

Characteristic	No abuse as child or teen (n = 11,980)	Any child abuse (n = 13,885)	Any teen abuse (n = 10,497)	Abuse as both child and teen (n = 7,906)
Age at baseline (y), mean ± SD	40.2 ± 11.0	37.7 ± 10.0	37.6 ± 9.7	37.4 ± 9.6
College graduate	51	50	46	47
Income of ≥\$50,000 (2003)	54	54	51	51
Has health insurance (1997)	88	88	87	87
Had a regular doctor (1997)	83	83	83	83
Parental history of asthma (1999)	6	7	7	7
Presence of sleep apnea (2001)	2	2	2	3
Female hormone use ever	14	15	15	16
BMI (kg/m <sup>2</sup> ), mean ± SD	27.3 ± 6.2	27.8 ± 6.7	28.0 ± 6.7	28.1 ± 6.8
Five or more hours/week of vigorous exercise	12	14	14	14
Past drinker	12	15	16	17
Current drinker	22	26	27	26
Current smoker	13	15	16	17
Pack years of smoking among current/past smokers (mean ± SD)	10.7 ± 11.2	12.6 ± 12.6	12.7 ± 12.5	13.1 ± 12.8
Exposure to secondhand smoke (1997)				
Ages 0-10 y	44	51	51	53
Ages 11-20 y	42	50	52	53
Ages 21-30 y	44	51	53	54
Ages 31-40 y	30	33	35	35
Currently	17	17	19	18
Any abuse as an adult (2005)	25	51	59	62
Scored ≥16 on CES-D scale (2005 [high-level depressive symptoms])	20	29	32	33
Highest quartile Perceived Stress Scale (2005 [most stressed])	21	30	32	34
Lowest quartile COPE score (2005 [fewest coping skills])	25	24	23	23

Values are presented as percentages unless otherwise noted.

\*Age adjusted in 5-year intervals.

†Ascertained at baseline in 1995 unless a different year is noted in parentheses.

(*P* for interaction > .05). Regardless of age at asthma diagnosis, the difference in IRRs by baseline age persisted.

To assess whether recall bias influenced the effect estimates, we calculated IRRs for childhood physical abuse, confining follow-up to the years after abuse was ascertained in 2005 (Table V). IRRs from the later follow-up period were higher than those from the entire follow-up period. The variation in IRRs by age was also apparent in the late follow-up period (data not shown).

The association of childhood physical abuse with asthma incidence was present within strata of smoking (ever/never), CES-D score (<16, ≥16), COPE and stress scales (less than median, median or greater), baseline BMI (<25 kg/m<sup>2</sup>, 25-29 kg/m<sup>2</sup>, ≥30 kg/m<sup>2</sup>), and presence of adult abuse (ever/never) all *P* for interaction > .05, data not shown.

When we confined the cases to those who reported use of an asthma preventative (eg, fluticasone) and thus might have had more severe asthma (769 cases), the IRRs were similar to the main results (eg, IRR for any child abuse, 1.23; 95% CI, 1.02-1.49). When we used a less stringent case definition and included as cases all women who reported physician-diagnosed asthma regardless of the use of asthma medications (2268 cases), the IRRs for childhood abuse were also similar to the main results (eg, IRR for any child abuse, 1.22; 95% CI, 1.09-1.37). The results were also unchanged in analyses that included cases who reported childhood asthma (1267 total cases).

## DISCUSSION

In this large cohort of African American women, exposure to physical abuse during childhood was associated with an increased

incidence of adult-onset asthma of greater than 20%. The risk was higher among women who also felt in danger in the home as a child. IRRs were weaker for sexual abuse during childhood, and there was little evidence that abuse during adolescence increased asthma incidence. The adverse effect of childhood physical abuse was confined to older women.

Two previous studies have assessed the relation of childhood abuse with adult asthma. In a small cross-sectional study of 354 women sampled from a community in New Zealand,<sup>11</sup> the prevalence of asthma (*n* = 33) was twice as high in women who reported any sexual abuse before age 16 years compared with those who did not; asthma was not associated with childhood physical abuse. Results from the much larger cross-sectional, 10-country World Mental Health study<sup>12</sup> are consistent with those of the present study. On the basis of 649 cases of adult-onset asthma reported by 18,303 participants who were interviewed about experiences of childhood abuse, the hazard ratio for adult asthma was 1.92 (95% CI, 1.32-2.81) among those who reported physical abuse and 1.26 (95% CI, 0.84-1.82) among those who reported childhood sexual abuse.<sup>12</sup>

A study of war-related stressors and asthma incidence in Kuwait after the 1990 Iraqi invasion supports the notion that stress can contribute to adult-onset asthma.<sup>22</sup> In that study, adults reporting the highest stress exposure were more than twice as likely to report incident asthma over 13 years of follow-up as those reporting no stressors. In addition, several cross-sectional studies have found that trauma, abuse, or both during adulthood were positively associated with adult asthma prevalence.<sup>23-26</sup> We did not assess asthma incidence in relation to adult abuse because we did not know which came first until

**TABLE II.** Abuse during childhood and adolescence and risk of adult-onset asthma, BWHS, 1995-2011

	Cases/person-years	Basic IRR* (95% CI)	Multivariable IRR† (95% CI)
<b>Stage of abuse</b>			
No abuse as child or teen	411/176,185	1.0	1.0
Any child abuse	646/203,626	1.28 (1.09-1.49)	1.24 (1.06-1.45)
Any teen abuse	492/153,657	1.18 (0.95-1.47)	1.10 (0.88-1.36)
Child abuse only	257/88,088	1.27 (1.09-1.49)	1.24 (1.06-1.45)
Teen abuse only	103/38,120	1.18 (0.95-1.46)	1.10 (0.88-1.36)
Both child and teen abuse	389/115,537	1.48 (1.29-1.70)	1.29 (1.12-1.48)
<b>Childhood abuse</b>			
Type of childhood abuse			
Physical abuse only	406/128,517	1.28 (1.09-1.51)	1.26 (1.07-1.49)
Sexual abuse only	73/25,451	1.20 (0.92-1.56)	1.15 (0.88-1.49)
Physical and sexual abuse	167/49,657	1.34 (1.08-1.67)	1.24 (1.00-1.55)
Frequency of childhood physical abuse			
Low	236/79,922	1.23 (1.02-1.47)	1.22 (1.01-1.46)
Intermediate	134/39,229	1.40 (1.11-1.76)	1.38 (1.10-1.73)
High	203/59,024	1.41 (1.12-1.76)	1.35 (1.08-1.69)
Frequency of childhood sexual abuse			
1-3 Incidents	151/51,708	1.13 (0.85-1.51)	1.09 (0.82-1.46)
≥4 Incidents	89/23,400	1.43 (1.00-2.04)	1.28 (0.90-1.83)
<b>Adolescent abuse</b>			
Type of teen abuse			
Physical abuse only	228/72,763	1.19 (0.93-1.52)	1.12 (0.87-1.43)
Sexual abuse only	121/42,657	1.12 (0.87-1.43)	1.05 (0.82-1.34)
Physical and sexual abuse	143/38,238	1.39 (1.06-1.84)	1.23 (0.93-1.62)
Frequency of teen physical abuse			
Low	182/60,686	1.10 (0.82-1.48)	1.06 (0.79-1.43)
Intermediate	83/23,424	1.27 (0.88-1.82)	1.16 (0.81-1.66)
High	106/26,891	1.38 (0.96-1.98)	1.22 (0.85-1.76)
Frequency of teen sexual abuse			
1-3 Incidents	211/66,359	1.10 (0.84-1.45)	1.04 (0.79-1.37)
≥4 Incidents	53/14,536	1.16 (0.77-1.73)	1.04 (0.70-1.57)

\*Adjusted for age and calendar time. Child abuse variables are adjusted for teen abuse, and teen abuse variables are adjusted for child abuse. Sexual abuse variables are adjusted for physical abuse, and physical abuse variables are adjusted for sexual abuse. †Adds to the basic model parental history of asthma (yes, no, unknown); income (≤\$25,000, \$25,001-\$50,000, \$50,001-\$100,000, >\$100,000, missing); number in household supported by the income (1, 2, 3-4, ≥5, missing); years of education (≤12, 13-15, 16, ≥17); years of hormone therapy use (never, <5, ≥5, missing); BMI (<25 kg/m<sup>2</sup>, 25-29 kg/m<sup>2</sup>, 30-34 kg/m<sup>2</sup>, 35-39 kg/m<sup>2</sup>, ≥40 kg/m<sup>2</sup>, missing); hours/week of vigorous exercise (none, <5, ≥5, missing); secondhand smoke exposure at ages 0 to 10, 11 to 20, 21 to 30, and 31 to 40 years and currently (yes, no, missing); current smoking (yes, no); pack years of smoking (never smoked, <5, 5-14, 15-24, ≥25, missing); and alcohol consumption (never, past, current 1-3/week, 4-6/week, 7-13/week, ≥14/week, missing).

2005, when abuse was ascertained; in analyses confined to follow-up after 2005, there was no relation between adult abuse and asthma incidence. When we included adult abuse as a potential mediator, the IRRs for childhood physical abuse were not materially changed.

The observed association of childhood physical abuse with adult-onset asthma could result from the stress caused by the abuse persisting into adulthood<sup>13,14</sup> and adversely affecting the immune system, the airways, and/or the autonomic nervous system. Stress has been shown to be associated with more severe

**TABLE III.** IRRs for asthma according to child abuse and whether danger was felt in the home, BWHS, 1995-2011

	Cases/person-years	Multivariable IRR* (95% CI)
No danger felt in home and no child or teen abuse	389/167,031	1.0
<b>Never felt in danger in home</b>		
Any child abuse	400/134,666	1.18 (1.03-1.35)
Any physical abuse as child	359/119,200	1.24 (1.04-1.47)
Frequency of child physical abuse		
Low	185/63,320	1.24 (1.02-1.50)
Intermediate	84/26,232	1.32 (1.02-1.71)
High	90/29,648	1.26 (0.97-1.64)
Any sexual abuse as child	96/33,093	1.12 (0.83-1.51)
<b>Yes, felt in danger in home</b>		
Any child abuse	237/66,100	1.31 (1.11-1.56)
Any physical abuse as child	206/56,694	1.40 (1.12-1.74)
Frequency of child physical abuse		
Low	46/15,347	1.25 (0.88-1.76)
Intermediate	49/12,601	1.63 (1.16-2.30)
High	111/28,746	1.53 (1.15-2.03)
Any sexual abuse as child	140/40,819	1.17 (0.83-1.64)

\*Adjusted for age; calendar time; parental history of asthma (yes, no, unknown); income (≤\$25,000, \$25,001-\$50,000, \$50,001-\$100,000, >\$100,000, missing); number in household supported by the income (1, 2, 3-4, ≥5, missing); years of education (≤12, 13-15, 16, ≥17); years of hormone therapy use (never, <5, ≥5, missing); BMI (<25 kg/m<sup>2</sup>, 25-29 kg/m<sup>2</sup>, 30-34 kg/m<sup>2</sup>, 35-39 kg/m<sup>2</sup>, ≥40 kg/m<sup>2</sup>, missing); hours/week of vigorous exercise (none, <5, ≥5, missing); secondhand smoke exposure at ages 0 to 10, 11 to 20, 21 to 30, and 31 to 40 years and currently (yes, no, missing); current smoking (yes, no); pack years of smoking (never smoked, <5, 5-14, 15-24, ≥25, missing); alcohol consumption (never, past, current 1-3/week, 4-6/week, 7-13/week, ≥14+/week, missing); and adolescent abuse (ever, never). Physical abuse variables are adjusted for sexual abuse, and any sexual abuse is adjusted for physical abuse.

airway inflammation and airflow obstruction in an allergen inhalation challenge among subjects with established asthma.<sup>27</sup> In a mouse model of allergic airway inflammation, stress was observed to worsen the histopathologic changes of inflammation in the airways.<sup>28</sup> Alternatively, stress in childhood could lead to long-lasting or even permanent alterations in the immune system, the airways, or the autonomic nervous system that predispose to the development of asthma decades after the abuse occurred. During infancy and early childhood, adaptive immunity is undergoing maturation, and the airways are undergoing growth and epithelial changes.<sup>29</sup> Animal data also suggest that the innervation of the airways continues to develop in early post-natal life and can be altered by environmental exposures,<sup>30</sup> thereby influencing the risk of airway hyperresponsiveness. Environmental factors and their physiologic consequences, including stress, that affect these developmental processes in childhood, especially early childhood, could have sequelae many years later that influence asthma risk. Exposures during this key developmental period could have a greater effect, even on outcomes occurring in later adulthood, than exposures encountered in adolescence or young adulthood.

There is no ready explanation for our observation that the adverse effect of child abuse was stronger in women aged 40 years and older at baseline. Lung function decreases with age,<sup>31</sup> and perhaps the effect of early-life stress manifests most strongly in the aging lung.

Asthma was self-reported in the present study. There is no gold standard for defining asthma,<sup>32,33</sup> and in a large national study

**TABLE IV.** Abuse during childhood and risk of adult-onset asthma by age, BWHS, 1995-2011

	Cases/person-years	Multivariable IRR* (95% CI)
Age <40 y at baseline		
No abuse as child or teen	199/89,083	1.0
Any child abuse	320/120,223	1.07 (0.85-1.33)
Type of child abuse		
Physical abuse only	190/74,071	1.06 (0.84-1.35)
Sexual abuse only	37/15,016	1.01 (0.70-1.46)
Physical and sexual abuse	93/31,136	1.13 (0.84-1.53)
Frequency of child physical abuse		
Low	103/45,200	0.96 (0.73-1.26)
Intermediate	69/22,846	1.27 (0.92-1.75)
High	111/37,162	1.18 (0.86-1.62)
Age ≥40 y at baseline		
No abuse as child or teen	212/87,102	1.0
Any child abuse	326/83,402	1.43 (1.14-1.78)
Type of child abuse		
Physical abuse only	216/54,446	1.48 (1.17-1.86)
Sexual abuse only	36/10,435	1.27 (0.87-1.84)
Physical and sexual abuse	74/18,521	1.35 (0.99-1.86)
Frequency of child physical abuse		
Low	133/34,723	1.49 (1.16-1.91)
Intermediate	65/16,383	1.46 (1.06-2.02)
High	92/21,862	1.54 (1.11-2.14)

\*Adjusted for age; calendar time; parental history of asthma (yes, no, unknown); income (≤\$25,000, \$25,001-\$50,000, \$50,001-\$100,000, >\$100,000, missing); number in household supported by the income (1, 2, 3-4, ≥5, missing); years of education (≤12, 13-15, 16, ≥17); years of hormone therapy use (never, <5, ≥5, missing); BMI (<25 kg/m<sup>2</sup>, 25-29 kg/m<sup>2</sup>, 30-34 kg/m<sup>2</sup>, 35-39 kg/m<sup>2</sup>, ≥40 kg/m<sup>2</sup>, missing); hours/week of vigorous exercise (none, <5, ≥5, missing); secondhand smoke exposure at ages 0 to 10, 11 to 20, 21 to 30, and 31 to 40 years and currently (yes, no, missing); current smoking (yes, no); pack years of smoking (never smoked, <5, 5-14, 15-24, ≥25, missing); alcohol consumption (never, past, current 1-3/week, 4-6/week, 7-13/week, ≥14/week, missing); and adolescent abuse (ever, never). Physical abuse variables are adjusted for sexual abuse, and sexual abuse is adjusted for physical abuse.

like the BHWS, it is infeasible to clinically examine all cases to verify asthma. It is also impossible to examine all noncases to identify undiagnosed asthma. Thus self-reported physician-diagnosed asthma has been recommended as the preferred outcome for use in large population-based studies<sup>34</sup> and has been used in many prospective epidemiologic studies.<sup>35-38</sup> To increase specificity, we included use of an asthma medication in the case definition. In a validation study among 43 women who met our case definition and who gave us permission to contact their physicians, 39 (91%) were confirmed by their physicians as having asthma. In the present analysis the association between childhood abuse and asthma incidence was robust to both more stringent and less stringent case definitions.

Detection bias might have occurred if women with childhood abuse were more likely to go to the doctor and complain of asthma symptoms than women who were not abused. Evidence against detection bias is as follows: almost all BWHS participants had access to health care and health insurance regardless of abuse, adjustment for these factors did not change the results, and results were similar when we restricted cases to those who might have had more severe asthma.

We relied on self-reported abuse and were unable to validate abuse occurrence, type, or severity. However, the abuse questions

**TABLE V.** Abuse during childhood and risk of adult-onset asthma during later years of follow-up, BWHS, 2005-2011

	Cases/person-years	Multivariable IRR* (95% CI)
No abuse as child or teen	83/58,155	1.0
Any child abuse	138/67,542	1.34 (0.95-1.88)
Type of childhood abuse		
Physical abuse only	92/42,606	1.46 (1.03-2.09)
Sexual abuse only	11/8,462	0.90 (0.47-1.72)
Physical and sexual abuse	35/16,474	1.32 (0.83-2.13)
Frequency of childhood physical abuse		
Low	56/26,626	1.42 (0.96-2.10)
Intermediate	27/12,973	1.39 (0.84-2.29)
High	44/19,481	1.47 (0.90-2.38)
Frequency of childhood sexual abuse		
1-3 Incidents	29/17,263	0.99 (0.50-1.95)
≥4 Incidents	17/7,673	1.22 (0.54-2.79)

\*Adjusted for age; calendar time; parental history of asthma (yes, no, unknown); income (≤\$25,000, \$25,001-\$50,000, \$50,001-\$100,000, >\$100,000, missing); number in household supported by the income (1, 2, 3-4, ≥5, missing); years of education (≤12, 13-15, 16, ≥17); years of hormone therapy use (never, <5, ≥5, missing); BMI (<25 kg/m<sup>2</sup>, 25-29 kg/m<sup>2</sup>, 30-34 kg/m<sup>2</sup>, 35-39 kg/m<sup>2</sup>, ≥40 kg/m<sup>2</sup>, missing); hours/week of vigorous exercise (none, <5, ≥5, missing); secondhand smoke exposure at ages 0 to 10, 11 to 20, 21 to 30, and 31 to 40 years and currently (yes, no, missing); current smoking (yes, no); pack years of smoking (never smoked, <5, 5-14, 15-24, ≥25, missing); alcohol consumption (never, past, current 1-3/week, 4-6/week, 7-13/week, ≥14/week, missing); and adolescent abuse (ever, never). Physical abuse variables are adjusted for sexual abuse, and sexual abuse is adjusted for physical abuse.

were based on instruments that have been widely used and have demonstrated high reproducibility both within our cohort<sup>18</sup> and in other studies.<sup>16,17</sup> Recall bias could have occurred if women who had asthma overreported abuse or were more likely to remember abuse compared with women who did not have asthma. The fact that the IRRs from the late follow-up period based on cases that developed after the report of child abuse in 2005 were higher than the IRRs from the main analysis argues against recall bias.

Our analyses included many comparisons, which increases the chance that some significant associations might be spurious. Nevertheless, our finding of an association of childhood physical abuse with adult-onset asthma is credible in light of similar findings from the World Mental Health Study.<sup>12</sup> Confirmation from other prospective studies is desirable.

In conclusion, ours is the first longitudinal study to provide evidence of a positive association between childhood physical abuse and adult-onset asthma. This relation has not previously been assessed in African American women. According to the Department of Health and Human Service's National Child Abuse and Neglect Data System,<sup>4</sup> in 2010, approximately 695,000 children aged 0 to 17 years were determined by state Child Protective Service agencies to be neglected or abused, of which 18% was physical abuse. The true prevalence of child abuse might be much higher given underreporting.<sup>39,40</sup> In light of the high prevalence of abuse and asthma in the United States, the association is of public health importance. Clinicians should be vigilant in screening for and intervening to stop child abuse not only to prevent acute physical injuries and psychological effects but also to prevent long-term medical sequelae, such as asthma.

### Key messages

- In this large cohort of African American women, there was a positive association between childhood abuse and adult-onset asthma.
- The association was stronger for childhood physical than sexual abuse and was stronger in older compared with younger women.
- The hypothesized mechanism linking abuse to asthma incidence is stress and its physiologic consequences, particularly effects on the immune system.

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