

OBESITY

Association of General and Central Obesity and Atopic and Nonatopic Asthma in US Adults

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Objective. To examine the association of body mass index (BMI), waist circumference (WC), and waist-to-height ratio (WHtR) with the prevalence of asthma by atopic status and sex using nationally representative data in the US. **Methods.** The National Health and Nutrition Examination Survey 2005–2006 data were analyzed using areas under the receiver operating characteristic (ROC) curves (AUCs) and multivariate logistic regression models. **Results.** Women had higher AUCs (0.59–0.64) than men (0.50–0.58) across anthropometric indices and asthma outcomes. After controlling for sociodemographic characteristics and smoking status, only WHtR was positively associated with atopic asthma in both sexes (odds ratio per 1 SD [95% confidence interval]: men, 1.018 [1.004, 1.032], $p = .01$; women, 1.018 [1.006, 1.030], $p = .003$), and the associations persisted after further adjustment of BMI. Only in women was nonatopic asthma significantly associated with every 1 SD increase of BMI (odds ratio [95% confidence interval]: 1.018 [1.006, 1.030], $p = .003$), WC (1.018 [1.006, 1.030], $p = .004$), and WHtR (1.016 [1.004, 1.028], $p = .008$). **Conclusions.** Using US national data, this study adds to the emerging evidence suggesting two possible distinct phenotypes: (1) obese men and women with atopic asthma and (2) obese women with nonatopic asthma. The mechanistic and therapeutic implications of these findings warrant further investigation.

Keywords asthma, atopy, body mass index, obesity, waist circumference, waist-to-height ratio

INTRODUCTION

Obesity increases the incidence of asthma (1) and may render prevalent asthma more difficult to control (2–5). The relative importance of body weight and fat distribution in obesity-attributable morbidity remains controversial (6–8). As an indirect measure of generalized adiposity, body mass index (BMI) cannot, by definition, distinguish between excesses in fat mass and lean mass or the anatomic distribution of adipose tissue (e.g., upper vs. lower, central vs. peripheral). This intrinsic limitation of BMI has led to increasing doubt about the value of this most-studied obesity index in predicting disease risk, particularly given the evidence that abdominal adiposity may be a stronger determinant of obesity-related cardiometabolic morbidity (9). The peculiar metabolism and anatomic location of visceral adipose tissue is thought to contribute to the increased metabolic and hemodynamic risks associated with central fat distribution (6, 10, 11). A different school of thought believes that BMI is highly correlated with various measures of central adiposity, with clinically equivalent predictive power (12–14). Further, others have contended that the predictive power of anthropometric indices depends on the clinical endpoint studied and may vary by population characteristics, such as sex (12, 13, 15, 16).

Very few studies have examined the relation of anthropometric indices other than BMI to asthma among US adults, using population-based data. The purpose of this study was to examine the association of BMI, waist circumference (WC), and waist-to-height ratio (WHtR) with the prevalence of current asthma stratified by atopic status and sex, using data from a nationally representative sampling survey in the US. We also assessed sex-specific cutoffs that would optimize the sensitivity and specificity of identifying atopic and non-atopic asthma.

METHODS

Study Population

The National Health and Nutrition Examination Survey (NHANES) uses a stratified, multistage probability cluster sampling design and weighting methodology that allows unbiased estimates to be produced for the civilian, noninstitutionalized US population (detailed documentation and public-use data files available at <http://www.cdc.gov/nchs/nhanes.htm>). A total of 10,348 individuals of all ages were included in NHANES 2005–2006, which is the most-recent data released to date, which contained the variables necessary for this study. The overall participation rates were 80.5% for the household interviews and 77.3% for the examinations. In this study, we focused on 4182 men and nonpregnant women aged 20 years and older, who had been randomly selected for allergen-specific serum IgE tests and for medical condition interviews.

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MEASUREMENTS

Atopy and Asthma Outcomes

In the 2005–2006 NHANES, serum samples were analyzed for total and allergen-specific IgE using the Pharmacia Diagnostics ImmunoCAP 1000 System (Kalamazoo, Michigan). The types of allergies for which specific IgE tests were performed included: two house dust mites (*Dermatophagoides Farinae* and *Dermatophagoides Pteronyssinus*), five animal danders (cat, dog, cockroach, mouse, and rat), two fungi (alternaria and aspergillus), four grasses (ragweed, rye, thistle, and bermuda), and two trees (oak and birch). A concentration for specific IgE ≥ 0.35 kU/L was defined as a positive test result (17, 18). Atopy was defined by a positive result for any of the assays listed above.

Consistent with previous NHANES reports (19–21), current asthma was defined based on affirmative responses to both questions “Has a doctor or other health professional ever told you that you have asthma?” and “Do you still have asthma?” in the medical conditions questionnaire. Atopic asthma was defined as participants having both atopy and asthma, while nonatopic asthma was defined as having asthma but no atopy.

Body Mass Index. Height and weight were measured by trained technicians using standardized protocols and calibrated equipment. BMI was calculated to the nearest 0.1 kg/m^2 and categorized according to the recommended cut points as follows: underweight ($<18.5 \text{ kg/m}^2$), normal weight ($18.5\text{--}24.9 \text{ kg/m}^2$), overweight ($25.0\text{--}29.9 \text{ kg/m}^2$), and obese ($\geq 30.0 \text{ kg/m}^2$) (22).

Waist Circumference. WC, an accepted clinical indicator of abdominal obesity, was measured (to the nearest 0.1 cm) in a horizontal plane around the abdomen, at the level of the uppermost lateral border of the right ilium. The conventional cut points for WC categories are sex-specific: normal (men, <94 cm; women, <80 cm), overweight (men, $94\text{--}<102$ cm; women, $80\text{--}<88$ cm), and obese (men, ≥ 102 cm; women, ≥ 88 cm) (23).

Waist-to-height Ratio. WC and height measurements were used to derive the WHtR ratio. Past studies of the relation of WHtR with health risks have defined WHtR ≥ 0.5 as obese and WHtR <0.5 as normal (24).

Sociodemographic Characteristics and Smoking Status. We categorized participants by age (20–44, 45–64, and ≥ 65 years), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other [including multirace]), annual family income ($<\$20,000$, $\$20,000\text{--}<\$45,000$, $\$45,000\text{--}<\$75,000$, or $\geq \$75,000$), education (less than high school, high school, or college level or more), and smoking status (never, current, or former smoker).

STATISTICAL ANALYSIS

F-tests (for continuous variables) or chi-square tests (for categorical variables) evaluated differences in sociodemographic characteristics, smoking status, anthropometric

indices (BMI, WC, and WHtR), and asthma status (atopic and nonatopic asthma and no asthma) by sex. Correlations among anthropometric indices were assessed graphically and by Pearson correlation analyses, controlling for age. Discordance in obesity classification according to the above-mentioned conventional cutoffs of the anthropometric indices was evaluated by the chi-square test.

We compared the discriminative power of the anthropometric indices for current asthma by atopic status in two ways. First, we used the receiver operating characteristic (ROC) curve analysis to estimate each anthropometric index's sensitivity (i.e., the proportion of being obese among individuals with asthma) and specificity (i.e., the proportion of being nonobese among individuals without asthma) for the asthma outcome tested. The area under an ROC curve (AUC) quantified the ability of each anthropometric index (without covariate adjustment) to discriminate between the presence and absence of an asthma outcome over the continuum of all possible cutoffs. The higher the AUC, the better the index separated individuals with and without the asthma outcome, with an AUC of 1 indicating perfect separation and that of 0.5 no separation at all. Youden's index $J = \max_o [\text{Sensitivity}(o) + \text{Specificity}(o) - 1]$ defined the cutoff o of the anthropometric index that would optimize the identification of the asthma outcome, that is “optimal” cutoff (25). For comparisons, we also calculated sensitivity, specificity, and Youden's index according to conventional cutoffs for the three anthropometric indices. Second, to quantify the strength of association of each anthropometric index with current asthma independent of potential confounders, we estimated odds ratios with 95% confidence intervals (CIs) in two multivariate logistic regression models. The first model controlled for sociodemographic characteristics and smoking status, while the second controlled for all model 1 covariates plus BMI for WC and WHtR and WC for BMI. Separate analyses were conducted by sex and atopic status. We assessed the goodness of fit of the models using the Akaike information criterion (AIC), a lower value indicating a better model fit (26); and the discrimination ability using the C index, a higher value indicating a better discrimination ability (27).

All analyses were conducted using the Statistical Analysis System (SAS) survey procedures (version 9.2; SAS Institute Inc) to account for NHANES' complex sampling design and sample weights. Statistical significance was set at $p < .05$ (2-sided).

RESULTS

The study sample included 324 adults with current asthma (194 with atopic asthma and 130 with nonatopic asthma) and 3858 adults without (Table 1). The overall prevalence of current asthma was 8% (6% in men and 10% in women), that is 5% atopic (4% in men and 5% in women) and 3% nonatopic (2% in men and 5% in women). Table 1 shows the sex differences in the sociodemographic characteristics, smoking status, and anthropometric indices.

TABLE 1.—Characteristics of the study population: US men and women aged 20 years and over, NHANES 2005–2006.

Characteristic	Survey participants, No. ^a	Estimated population, No. in millions ^b	All participants	Men	Women	<i>p</i> -value
Sociodemographic						
Sex, % ^c						
Female	2151	95	49	N/A	N/A	
Male	2031	99	51	N/A	N/A	
Mean (± SD) age, years	4182	195	47.2 ± 0.7	46.1 ± 0.8	48.2 ± 0.8	.002
Age category, % ^c						<.001
20–44 years	1792	90	46	48	45	
45–64 years	1329	70	36	36	36	
≥65 years	1061	34	18	16	20	
Race/ethnicity, % ^c						.01
Hispanic	939	22	11	12	10	
Non-Hispanic white	2131	142	73	73	72	
Non-Hispanic black	956	21	11	10	12	
Other	156	10	5	4	6	
Income, % ^c						<.001
\$20,000	976	32	17	15	19	
\$20,000–\$45,000	1331	56	29	30	29	
\$45,000–\$75,000	827	45	24	24	24	
≥\$75,000	881	56	30	31	28	
Education, % ^c						.08
Less than high school (12th grade)	1156	34	17	19	16	
High school (12th grade or GED)	998	49	25	25	25	
College level or more	2023	112	58	56	59	
Smoking status, % ^c						<.001
Never smoker	2143	98	51	43	57	
Current smoker	961	48	24	28	21	
Former smoker	1075	49	25	29	21	
Anthropometric						
Mean (± SD) BMI, kg/m ²	4117	195	28.6 ± 0.2	28.6 ± 0.3	28.6 ± 0.3	.82
BMI category, % ^c						<.001
Underweight, <18.5 kg/m ²	70	3	2	1	2	
Normal, 18.5–<25 kg/m ²	1182	60	31	25	36	
Overweight, 25–<30 kg/m ²	1408	63	33	41	25	
Obesity, ≥30 kg/m ²	1454	66	34	33	36	
Mean (±SD) waist circumference, cm	4013	195	97.7 ± 0.7	101.4 ± 0.7	94.1 ± 0.7	<.001
Waist circumference category, % ^c						<.001
Normal, men: <94 cm; women: <80 cm	1025	51	27	33	21	
Overweight, men: 94–<102 cm; women: 80–<88 cm	802	38	53	46	60	
Obese, men: ≥102 cm; women: ≥88 cm	2183	100	20	22	18	
Mean (±SD) waist-to-height ratio	4009	195	0.58 ± 0.004	0.58 ± 0.004	0.58 ± 0.005	.21
Waist-to-height ratio category, % ^c						.004
Normal, 0.5	746	41	22	19	24	
Obese, ≥0.5	3260	148	78	81	76	
Atopy and asthma status, %^c						
No asthma	3858	179	92	94	90	<.001
Atopic asthma	194	10	5	4	5	
Nonatopic asthma	130	6	3	2	5	

BMI, body mass index; GED, General Education Diploma; N/A, not applicable; NHANES, National Health and Nutrition Examination Survey; SD, standard deviation.

^aNumbers do not always add up to the total $n = 4182$ because of missing data.

^bNHANES uses a stratified, multistage probability cluster sampling design and weighting methodology that allows unbiased estimates to be produced for the civilian, noninstitutionalized US population. All analyses accounted for the complex sampling design and sample weights.

^cColumn percentages.

Age-controlled correlations among the three anthropometric indices ranged from 0.91 to 0.97 in both genders (all $p < .001$, Figure 1). According to conventional cutoffs, discordant obesity classification occurred depending on the anthropometric indices considered. In particular, WHtR was notably discordant with BMI and WC. Of the nonobese, based on BMI, 22% and 72% of men and 38% and 63% of women were classified as obese using WC and WHtR, respectively (all $p < .001$). Of the nonobese, based

on WC, 65% men and 40% women were obese according to WHtR (all $p < .001$).

In men, the AUCs of anthropometric indices ranged from 0.55 to 0.58, with the exception of the AUC of BMI for nonatopic asthma, which was 0.50, indicating no discriminative power (Table 2). The AUCs were consistently higher in women than in men, ranging from 0.59 to 0.64 across anthropometric indices and asthma outcomes. In both men and women, BMI had the highest AUC for atopic

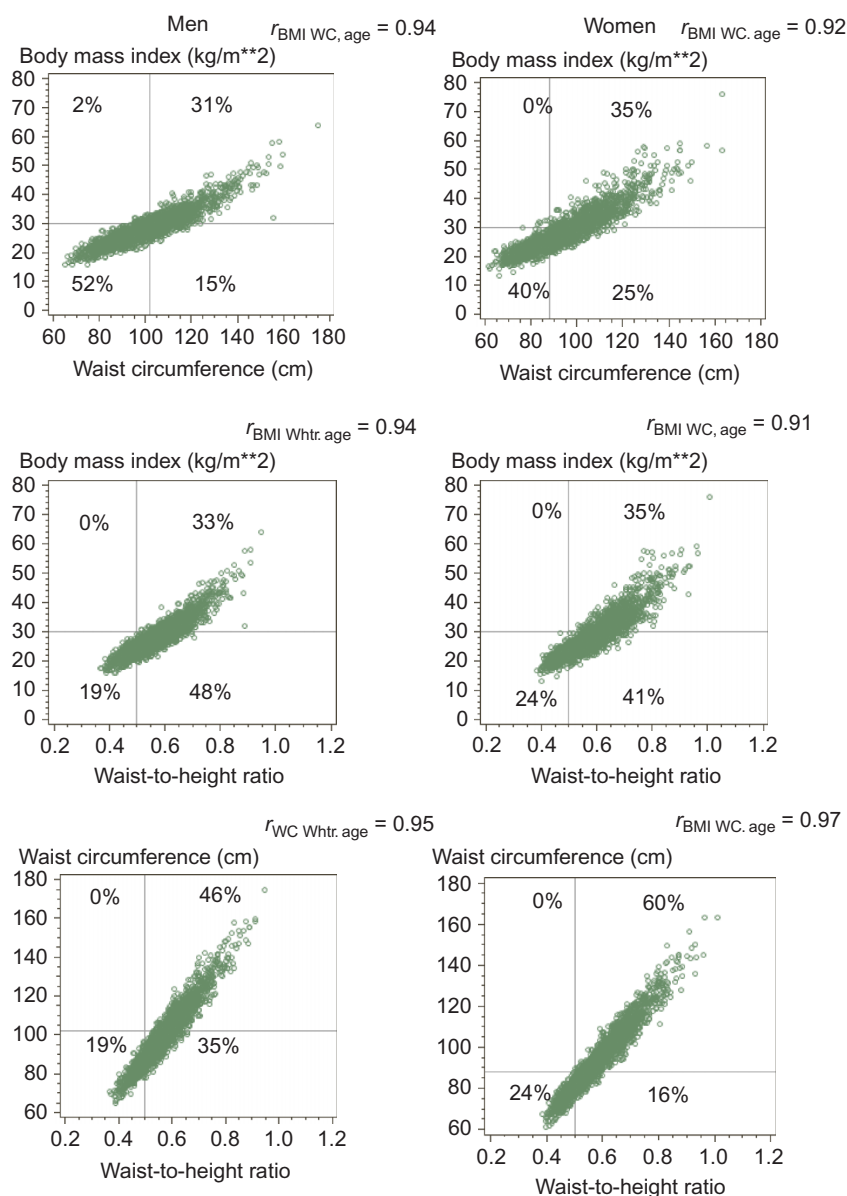


FIGURE 1.—Age-controlled Pearson partial correlations between anthropometric indices and obesity classification discordance according to conventional cutoffs. The reference lines indicate conventional obesity cutoffs for the anthropometric indices: body mass index at 30 kg/m², waist circumference at 102 cm for men and 88 cm for women, and waist-to-height ratio at 0.5.

asthma, while WC had the highest AUC for nonatopic asthma. In men, the sensitivity and specificity of identifying atopic and nonatopic asthma was optimized (as assessed by the Youden index) at a BMI of 30 kg/m², while the optimal cutoffs were 99 and 108 cm for WC and 0.57 and 0.6 for WHtR. In women, the optimal cutoffs for atopic and nonatopic asthma were 30 and 34 kg/m² for BMI, 101 and 102 cm for WC, and 0.66 and 0.68 for WHtR. When conventional cutoffs were used, BMI produced the best Youden index in all cases except in nonatopic asthma in men.

After controlling for sociodemographic characteristics and smoking status in men, neither BMI nor WC was associated with atopic or nonatopic asthma, while WHtR was positively associated with atopic asthma only ($p = .01$), which remained significant ($p = .02$) even

with further adjustment for BMI (Table 3). In women, 1 SD increases in all three anthropometric indices were associated with significantly greater odds of atopic and nonatopic asthma after controlling for sociodemographic characteristics and smoking status. None of these associations persisted in models simultaneously adjusted for BMI and WC or WHtR, except that WHtR remained a significant predictor of atopic asthma, independent of BMI ($p = .02$).

According to AIC, all models including WC or WHtR were better suited than the ones including BMI in men and women, and the models including WHtR were even more suited than the ones including WC, except for nonatopic asthma in women. Furthermore, models simultaneously including BMI and WC or WHtR (model 2) became better suited than including each anthropometric index alone

TABLE 2.—Areas under the receiver operating characteristic curves for different anthropometric indices in identifying atopic and nonatopic asthma and sensitivities and specificities according to optimal and conventional cutoffs in US men and women aged 20 years and over, NHANES 2005–2006.

	Men					Women				
	AUC	Cut point	Sensitivity (%)	Specificity (%)	Youden index (%)	AUC	Cut point	Sensitivity (%)	Specificity (%)	Youden index (%)
Optimal cutoffs										
Atopic asthma										
BMI	0.58	29.9	53	67	21	0.61	29.9	55	65	19
WC	0.56	98.7	68	47	14	0.59	102.4	44	71	16
WHtR	0.57	0.57	66	49	15	0.59	0.68	35	83	17
Nonatopic asthma										
BMI	0.50	29.5	50	63	13	0.62	34.1	43	80	24
WC	0.56	107.9	47	70	18	0.64	100.9	56	69	25
WHtR	0.55	0.6	50	65	15	0.62	0.66	42	77	19
Conventional cutoffs										
Atopic asthma										
BMI		30	4	68	18		30	51	65	16
WC		102	46	55	1		88	65	41	6
WHtR		0.5	82	19	1		0.5	80	24	5
Nonatopic asthma										
BMI		30	39	67	7		30	51	65	16
WC		102	52	55	7		88	73	41	14
WHtR		0.5	85	19	5		0.5	87	25	12

AUC, area under the receiver operating characteristic curve; BMI, body mass index; NHANES, National Health and Nutrition Examination Survey; WC, waist circumference; WHtR, waist-to-height ratio.

TABLE 3.—Adjusted odds ratios and discrimination of different anthropometric indices for atopic and nonatopic asthma in US men and women aged 20 years, NHANES 2005–2006.

	Men				Women			
	Odds ratio (95% CI)	p-value	C index	AIC	Odds ratio (95% CI)	p-value	C index	AIC
Atopic asthma								
Model 1 ^a								
BMI	1.007 (0.998, 1.016)	.13	0.642	31966460	1.013 (1.004, 1.022)	.003	0.664	38097616
WC	1.012 (0.999, 1.026)	.08	0.645	31590101	1.015 (1.004, 1.026)	.009	0.662	37958945
WHtR	1.018 (1.004, 1.032)	.01	0.658	31327451	1.018 (1.006, 1.030)	.003	0.669	37710331
Model 2 ^a								
BMI	1.012 (0.979, 1.046)	.47	0.650	31515512	1.009 (0.996, 1.022)	.17	0.664	37895476
WC	0.999 (0.962, 1.037)	.96	0.650	31515512	1.006 (0.988, 1.024)	.53	0.664	37895476
WHtR	1.053 (1.009, 1.099)	.02	0.649	31122389	1.027 (1.004, 1.050)	.02	0.668	37658356
Nonatopic asthma								
Model 1 ^a								
BMI	1.002 (0.990, 1.014)	.71	0.768	13930951	1.018 (1.006, 1.030)	.003	0.719	32763025
WC	1.000 (0.984, 1.016)	.97	0.761	12950084	1.018 (1.006, 1.030)	.004	0.720	32248389
WHtR	0.997 (0.983, 1.011)	.68	0.761	12943118	1.016 (1.004, 1.028)	.008	0.715	32408489
Model 2 ^a								
BMI	0.995 (0.951, 1.042)	.84	0.760	12936922	1.021 (0.988, 1.056)	.21	0.717	32044360
WC	1.005 (0.953, 1.059)	.86	0.760	12936922	0.996 (0.962, 1.030)	.81	0.717	32044360
WHtR	0.981 (0.928, 1.037)	.50	0.770	12919902	0.979 (0.943, 1.017)	.28	0.714	31915777

AIC, Akaike information criterion; BMI, body mass index; NHANES, National Health and Nutrition Examination Survey; WC, waist circumference; WHtR, waist-to-height ratio.

^aModel 1 was adjusted for age, sex, race/ethnicity, education, income, and smoking status, while model 2 was adjusted for all model 1 covariates plus BMI for WC and WHtR and WC for BMI. Odds ratios indicate the increased risk for 1 SD increase of each anthropometric index. AIC is a statistical estimate of the trade-off between the probability of a model against its complexity; a lower value indicates a better model fit. The C index is a measure of the discrimination ability of the models, with a higher value indicating better discrimination.

(model 1), in addition to adjusting for other covariates. The models including BMI and WHtR were the most suited within either asthma outcome for men and women. Within each asthma outcome, models with different anthropometric indices had largely the same C index, with minimum changes from model 1 to model 2, suggesting a comparable discriminative power.

DISCUSSION

This study builds on and extends the obesity and asthma epidemiology literature by including WHtR along with BMI and WC as an obesity determinant for the identification of current asthma modified by atopy and sex, and examining optimal cutoffs of the anthropometric indices for the asthma outcomes studied, in a population-based US

adult sample. The main findings are as follows: (1) the association of obesity and atopic asthma exists in both sexes and a high WHtR may confer risk independent of BMI; (2) the association of obesity and nonatopic asthma only exists in women with no clear evidence of better discriminative ability of WC or WHtR versus BMI; and (3) the conventional cutoffs, particularly for WC and WHtR in women, may be too low to optimize the diagnostic utility in atopic and nonatopic asthma.

The available literature is conflicting with regard to the nature of the obesity–asthma association according to different adiposity (e.g., abdominal vs. generalized) and asthma phenotypes (e.g., atopic vs. nonatopic) (28–31). The findings of this study are consistent with the emerging data, suggesting at least two possible distinct phenotypes of obese asthma patients: (1) early onset, atopic asthma that is complicated by coexisting obesity (found in both sexes) and (2) late onset, nonatopic asthma that is caused by obesity (found predominantly in women) (32).

The potential independent effect of a high WHtR in atopic asthma implies a mechanical mechanism where abdominal adiposity may lead to reduced lung volumes, airway narrowing, and altered muscle structure and function of the airway, which, in turn, could exacerbate the airway's hyper-responsiveness due to allergic inflammation (33, 34). In addition, the recent evidence that lung volumes may decrease with increasing duration of obesity (35) have implications for understanding the relationship between obesity and atopic asthma because atopic asthma typically originates in childhood and obesity tracks from childhood into adulthood. Further, studies show that height is inversely associated with morbidity and mortality (36) and that adverse environmental exposures (e.g., infections, poor socioeconomic circumstances, and smoking exposure) in critical growth periods play an important role in short stature and abdominal adiposity (37). These data support the biological plausibility of WHtR as a risk factor for atopic asthma independent of BMI.

Obese individuals with nonatopic asthma are increasingly recognized as a distinct phenotype whose pathophysiology may be dissociated with the typical lymphocytic and eosinophilic inflammation found in atopic asthma (32). These individuals tend to be female and have late onset asthma. A recent study showed a stronger association of asthma with total lean mass than with total fat mass and with truncal lean mass than with other regional distributions of lean and fat mass among women, but not among men (38). Another study suggested that lean mass was a measure of muscle bulk in men but that excess lean mass in women was a measure of obesity (39). Lean mass assessed by dual-energy X-ray absorptiometry, as in those studies, is not entirely fat-free. As a result, it is possible that the smaller, highly metabolically active ectopic fat within the skeletal muscle and viscera, rather than the excess physiological fat, drives the obesity–asthma association in women (38). This, if proven true, would at least partly explain the apparent comparability of BMI, WC, and WHtR for identifying nonatopic asthma in women because all

three measure a collection of fat and lean mass, with no ability to accurately differentiate specific types of tissues. The latter requires sophisticated imaging techniques that, unlike anthropometry, have limited practicality in routine clinical examination.

As expected, the three anthropometric indices are highly correlated, but this study finds considerable discordance in obesity classification according to their conventional cutoffs. In particular, WHtR classifies 48% men and 41% women differently than BMI, and it classifies 35% men and 16% women differently than WC. Some studies have reported elevated health risks associated with a large waist even in the presence of a normal BMI (9–11) and support the superiority of WHtR as a risk-screening tool (8), but the data are mixed (12–14). Identifying effective cutoffs to maximize the value of these anthropometric indices in relation to various health outcomes is important to clinical care and public health research. This study shows that the cutoffs at which the sensitivity and specificity of classifying atopic and nonatopic asthma are optimized are different from the conventional cutoffs, particularly for WC and WHtR. For example, the optimal cutoffs in women were >100 cm for WC and >0.65 for WHtR, compared to the conventional cutoffs of 88 cm (40) and 0.5 (24), respectively. However, all three anthropometric indices had modest AUCs, indicating their limited discriminative ability in asthma if used alone. Composite scoring tools, which include anthropometry and other known risk factors for asthma, may help improve the screening and diagnostic utility—an area warranting further investigation.

We designed the analyses *a priori* to examine the association of the three anthropometric indices with the prevalence of current asthma stratified by atopic status and sex based on prior evidence, clinical interest, and data interpretability. Growing evidence indicates that asthma, as defined by atopy and obesity, represents distinct phenotypes with possibly considerably different pathophysiological and therapeutic implications (32). And, the obesity–asthma association appears to be stronger in women than in men (1). In addition, prior studies have suggested that the predictive power of anthropometric indices may depend on the clinical endpoint and target population (12, 13, 15, 16). For example, the conventional WC cutoffs differ by sex; it would have been difficult to interpret the results if we had combined men and women. It is, however, important to note that this study is limited by its small sample sizes and cross-sectional design, and that the findings need to be confirmed in adequately powered, prospective observational and experimental studies.

Another study limitation is the definition of asthma by self-report, which is subject to recall bias and misclassification. However, it is not feasible for large epidemiological studies, such as NHANES, to validate all self-reported medical histories. The two-part definition of asthma used in this analysis (ever diagnosed and still have asthma) is consistent with other NHANES asthma reports (22–24).

In conclusion, this study shows that WHtR is associated with atopic asthma in both sexes, independent of BMI, and that the association of obesity and nonatopic asthma only exists in women and is robust to measures of general adiposity (BMI) and abdominal adiposity (WC or WHtR). These findings add to the growing evidence suggesting two obese, asthma phenotypes with possibly considerably different pathophysiological and therapeutic implications. The cutoffs identified in this study need to be confirmed in future prospective studies of asthma-related morbidity and mortality in diverse populations.

DECLARATION OF INTEREST

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