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WHAT WE EAT, DRINK, AND BREATHE

Atopy, Obesity, and Asthma in Adults: The Humboldt Study

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ABSTRACT. Obesity appears more strongly associated with asthma in women than in men. It is hypothesized that a stronger linkage of obesity with nonatopic asthma than with atopic asthma may explain the sex difference. That being the case, we might hypothesize a stronger association between obesity and asthma in nonatopic individuals than in atopic ones. In this analysis, we examined the association between obesity and asthma in atopic and nonatopic people separately. A total of 1997 residents aged 18 to 79 years who participated in the 2003–2004 Humboldt study were included in the analysis. Body mass index (BMI) and waist circumference were objectively measured. Allergy skin tests were conducted to determine atopic sensitization. Respiratory allergy and physician diagnosed asthma were self-reported. Overall, 8% reported having asthma, 30% had atopic sensitization as determined by allergy skin tests, 31% reported a history of respiratory allergy, and 35% were obese defined as BMI equal to or larger than 30 kg/m^2. Compared to those with a BMI <25 kg/m^2, the odds ratio for asthma for the nonatopic subjects of those with a BMI of at least 30.0 kg/m^2 was 2.01 (95% confidence interval [CI]: 1.13, 3.59] after adjustment for sex and age. The association between obesity and asthma was not statistically significant in atopic subjects. The adjusted odds ratios for obesity versus normal weight were 2.56 (95% CI: 1.07, 6.12) and 1.76 (95% CI: 1.04, 3.01) for those without and with a history of respiratory allergy, respectively. The association of asthma with waist circumference was not statistically significant in all the subgroups defined by

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atopy and respiratory allergy. The data suggested a stronger association between obesity and asthma among nonatopic people than among atopic people.

KEYWORDS. Allergy, asthma, atopic, cross-sectional study, nonatopic, obesity

INTRODUCTION

There is an increasing body of evidence for obesity being associated with an elevated risk of asthma in adults,[1–9] but the association is less consistent in children.[10,11] The proportion of persons with nonatopic asthma is higher in adults than in children. Previous studies have suggested that body mass index (BMI) is not associated with hayfever or nasal allergies, specific immunoglobulin E (IgE) to house dust mite, grass, or cat, or with total IgE.[12] However, it has been shown that severe obesity is associated with asthma but not with atopy and airway hyperresponsiveness,[13] suggesting that atopy may not be involved in the apparent association between obesity and asthma. It has been shown that obesity is more strongly associated with asthma in nonallergic than allergic individuals.[14] Central obesity was found significantly associated with an increased risk of nonatopic asthma but not of atopic asthma.[15] We hypothesize that obesity has a stronger impact on nonatopic or nonallergic asthma than on atopic or allergic asthma and the association between obesity and asthma is stronger in nonatopic or nonallergic than in atopic or allergic individuals. If this hypothesis holds, it may explain the discrepancy in the association of obesity with asthma among different subpopulations. In this study, we examined the associations between BMI, waist circumference, and asthma in atopic and nonatopic adults living in a rural community.

METHODS

We conducted a cross-sectional study in the rural town of Humboldt and surrounding area, Saskatchewan, in 2003. The target population of the study was all residents 18 to 79 years of age. There were 2090 persons who participated in the study, with a response rate of 70.1%. A questionnaire was completed by participants that requested information on sociodemographic factors, allergy, smoking, alcohol consumption, exercise, and the home environment.

We made an appointment for each adult participant to visit a clinic where lung function test, skin prick test, blood pressure, height, weight, waist circumference, and blood specimens were obtained. Weight was measured to the nearest 0.1 kg using a calibrated hospital spring scale with subjects dressed in normal indoor clothing without shoes. Height and waist circumference were measured in centimeters. Height was measured against a wall using a fixed tape measure with participants standing shoeless on a hard surface. Waist circumference was measured between the lowest rib and the iliac crest, horizontally through the narrowest part of the torso.[16] BMI was calculated as weight (kg)/[height (m)]^2. Skin prick testing included four allergens: *Dermatophagoides pteronyssinus*, mixed grasses (Western Allergy, Vancouver, CA), *Feld*, *Alternaria tenuis*, as well as positive (histamine) and negative (saline) controls (Omega Laboratories and Hollister-Stier, Mississauga, CA). Adults were considered atopic if they had a raised wheal >2 mm compared to the saline control on skin prick testing.[17]

Asthma was defined as asthma that had ever been diagnosed by a physician during the lifetime of the participant. Subjects were grouped into three categories based on BMI (<25.0, 25.0–29.9, and ≥30 kg/m^2) and two categories based on waist circumference (<100 and ≥100 cm). Current smokers were participants who reported smoking every day or almost everyday, and had smoked at least 20 packs during their lifetime. Ex-smokers were those who were regular smokers but at the time of the survey had quit for at least 6 months. Participants in the low education category did not

proceed beyond secondary school; the high education category included subjects admitted to college or university, as well as those with a postsecondary school certificate or diploma. Subjects were classified into low- (<$50,000) and high- (≥$50,000) income groups based on total household income. A positive history of respiratory allergy was defined by an affirmative response to the question: "Have you ever had an allergic reaction to things that are inhaled (e.g., pollen, dust, animal fur, or smoke)? Other variables included in the analysis were age (years), household size (<3 or ≥3 people), number of bedrooms (<4, ≥4), pets at home (yes, no), regular alcohol drinking (yes, no), and household dampness (yes, no).

This analysis was based on data from 1997 participants who had valid data of skin prick testing, BMI, respiratory allergy, and asthma. We calculated the prevalence of asthma and corresponding 95% confidence intervals (CI) according to various risk factors. Logistic regression models were used to evaluate associations between obesity variables and the prevalence of asthma, taking other important variables into consideration. Only sex and age notably changed the final estimates and other factors had little impact. Therefore, the final adjusted models only included sex and age as covariates. Model parameters were estimated by the method of maximum likelihood and were tested for significance using the Wald statistic.

RESULTS

Of 1997 participants, 8% reported having asthma, 30% had atopic sensitization, 31% reported a history of respiratory allergy, and 35% were obese defined as BMI ≥30 kg/m^2. Table 1 shows that the prevalence of asthma was higher in women than in men. Respiratory allergy, atopic sensitization and obesity were significantly associated with an increased risk of asthma.

Table 2 shows that the prevalence of asthma was increased with increasing BMI in those without atopic sensitization or self-reported history of respiratory allergy. The relationships were not significant in those with either atopic sensitization or self-reported respiratory allergy. The crude prevalence of asthma was not significantly associated with waist circumference when the study population was stratified by either atopic status or self-reported history of allergy (Table 2).

TABLE 1. Prevalence of Asthma According to Major Risk Factors, the Humboldt Study, 2003

	No.	Cases	Percent	*p* value
Sex				
Male	864	49	5.7	
Female	1133	111	9.8	<.001
Age (years)				
18–39	532	52	9.8	
40–59	778	58	7.5	
≥60	687	50	7.3	.215
Respiratory allergy				
No	1377	48	3.5	
Yes	620	112	18.1	<.001
Atopy				
No	1403	88	6.3	
Yes	594	72	12.1	<.001
Body mass index (kg/m^2)				
<25	539	35	6.5	
25–29.9	753	54	7.2	
≥30	705	71	10.1	.039
Waist circumference (cm)				
<100	1149	85	7.4	
≥100	644	54	8.4	
Unknown	204	21	10.3	.341

A multiple logistic regression model was used to assess the independent effects of BMI and waist circumference on the prevalence of asthma after controlling for potential confounders. Compared to those with a BMI <25 kg/m^2, the odds ratio for the nonatopic subjects of those with a BMI of at least 30.0 kg/m^2 was 2.01 (95% CI: 1.13, 3.59) after adjustment for sex and age (Table 3). Neither unadjusted nor adjusted odds ratios for atopic subjects was statistically significant. The adjusted odds ratios for obesity versus normal weight were 2.56 (95% CI: 1.07, 6.12) and 1.76 (95% CI: 1.04, 3.01) for those without and with a history of respiratory allergy, respectively. The association of asthma with waist circumference was not statistically significant in any of the subgroups defined by atopy and respiratory allergy.

TABLE 2. Prevalence of Asthma Associated with Body Mass Index and Waist Circumference in Atopic and Nonatopic Individuals, the Humboldt Study, 2003

	No.	Cases	Percent	χ^2 [trend] (*p* value)	No.	Cases	Percent	χ^2 [trend] (*p* value)
			Nonatopic				Atopic	
Body mass index (kg/m^2)								
<25	392	19	4.8		147	16	10.9	
25–29.9	541	30	5.5	[4.52]	212	24	11.3	[0.72]
≥30	470	38	8.3	(.033)	235	32	13.6	(.395
Waist circumference (cm)								
<100	817	49	5.6		332	39	11.7	
≥100	447	31	6.9	1.54	197	23	11.7	0.69
Unknown	139	11	7.9	(.462)	65	10	15.4	(.709)
			Without respiratory allergy				With respiratory allergy	
Body mass index (kg/m^2)								
<25	367	7	1.9		172	28	16.3	
25–29.9	530	19	3.6	[4.34]	223	35	15.7	[2.24]
≥30	480	22	4.6	(.037)	225	49	21.8	(.134)
Waist circumference (cm)								
<100	796	25	3.1		353	60	17.0	
≥100	444	16	3.6	1.37	200	38	19.0	0.75
Unknown	137	7	5.1	(.503)	67	14	20.9	(.686)

TABLE 3. Unadjusted and Adjusted* Odds Ratios (OR) and 95% Confidence Intervals (CI) for Asthma in Relation to Body Mass Index and Waist Circumference by Atopic Status and Respiratory Allergy, the Humboldt Study, 2003

	Unadjusted		Adjusted*		Unadjusted		Adjusted*	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
			Nonatopic				Atopic	
Body mass index (kg/m^2)								
<25	1.00		1.00		1.00		1.00	
25–29.9	1.15	0.64, 2.08	1.36	0.75, 2.50	1.05	0.54, 2.04	1.27	0.64, 2.53
≥30	1.78	1.01, 3.13	2.01	1.13, 3.59	1.29	0.68, 2.45	1.58	0.82, 3.04
Waist circumference (cm)								
<100	1.00		1.00		1.00		1.00	
≥100	1.25	0.78, 2.00	1.60	0.97, 2.63	0.99	0.54, 1.72	1.27	0.71, 2.26
Unknown	1.44	0.73, 2.85	1.52	0.76, 3.03	1.37	0.64, 2.90	1.69	0.78, 3.66
			Without respiratory allergy				With respiratory allergy	
Body mass index (kg/m^2)								
<25	1.00		1.00		1.00		1.00	
25–29.9	1.91	0.80,4.60	2.06	0.85, 5.00	0.96	0.56, 1.65	1.21	0.69, 2.13
≥30	2.47	1.04, 5.85	2.56	1.07, 6.12	1.43	0.86, 2.39	1.76	1.04, 3.01
Waist circumference (cm)								
<100	1.00		1.00		1.00		1.00	
≥100	1.15	0.61, 2.18	1.31	0.66, 2.58	1.15	0.73, 1.80	1.46	0.91, 2.34
Unknown	1.66	0.70, 3.92	1.63	0.68, 3.90	1.29	0.67, 2.47	1.35	0.70, 2.61

*Adjusted for age and sex.

DISCUSSION

Our results demonstrate that the association between obesity and asthma was significant in those without atopic sensitization but not in those with atopic sensitization. Consistent with a previous study,[14] the study also showed that the relationship between obesity and asthma was stronger in those without compared to those with self-reported history of respiratory allergy. These results suggest that obesity is more strongly associated with nonatopic or nonallergic asthma than atopic or allergic asthma. The modifying effect of atopy has also been found in previous studies. In a study of 4060 adults in Australia,[15] abdominal obesity was significantly associated with asthma in women but not in men. When stratified by atopic status, the relationship between obese levels of waist circumference and waist-hip ratio with asthma was significant in both men and women who were nonatopic, but not in those who were atopic.[15] In a large scale cohort study in Sweden, obese levels of BMI and waist circumference were significantly associated with an increasing incidence of nonatopic asthma only.[18] It appears that obesity is not associated with atopic status.[12,13,19]

Romanet-Manent and colleagues reported that nonatopic or nonallergic asthma is more likely to be adult-onset, more common in women and less common in children.[20] The present findings explain those observed in previous studies that the association between obesity and asthma is stronger in women than in men and the evidence for the association is weak in children, although the mechanisms are not known. There are some speculations about reasons for the modifying effects of allergy history[14] and atopic sensitization[15] on the relationship between obesity and asthma, but they need to be further explored in future studies.

There are several potential pitfalls in this study. Physician-diagnosed asthma was self-reported and therefore is subject to reporting bias. Another potential concern is over-diagnosis of asthma by physicians. A recent Canadian study found 30% of asthma patients with a label of "physician diagnosed asthma" were misdiagnosed, but the over diagnosis was almost the same in normal weight and obese groups (personal communication with Dr. Shawn Aaron), suggesting that obesity is not a reason for over diagnosis of asthma. In addition, because of the sample size of our population, we were not able to examine the modifying effects of atopy and respiratory allergy on the association between obesity and asthma further stratified by sex.

In summary, our results suggest that atopic sensitization and respiratory allergy modify the relationship between obesity and asthma in adults. The association between obesity and asthma was significant in the nonatopic group but not in the atopic group. Nonatopic asthma is more common in women than in men and in adults than in children. These study findings may explain previous observations of a more pronounced relationship between obesity and asthma in women than in other subpopulations.

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