Published in final edited form as:
Thorax. 2009 October ; 64(10): 889. doi:10.1136/thx.2009.114579.

Obesity, Waist Size, and Prevalence of Current Asthma in the California Teachers Study Cohort

Julie Von Behren[1], **Michael Lipsett**[2], **Pamela L. Horn-Ross**[1,3], **Ralph J. Delfino**[4], **Frank Gilliland**[5], **Rob McConnell**[5], **Leslie Bernstein**[6], **Christina A. Clarke**[1,3], and **Peggy Reynolds**[1,3]

[1] Northern California Cancer Center, Berkeley and Fremont, CA

[2] Environmental Health Investigations Branch, California Department of Public Health, Richmond, CA

[3] Department of Health Research and Policy, Stanford University School of Medicine, Stanford, CA

[4] Department of Epidemiology, School of Medicine, University of California, Irvine, CA

[5] Keck School of Medicine, University of Southern California, Los Angeles, CA

[6] Department of Cancer Etiology, City of Hope National Medical Center, Duarte, CA

Abstract

Obesity is a risk factor for asthma, particularly in women, but few cohort studies have evaluated abdominal obesity, which reflects metabolic differences in visceral fat known to influence systemic inflammation. We examined the relationships of asthma prevalence with measures of abdominal obesity and adult weight gain, in addition to body mass index (BMI), in a large cohort of female teachers. We calculated prevalence odds ratios (ORs) for current asthma using multivariable linear modeling, adjusting for age, smoking, and race/ethnicity. Of the 88,304 women in the analyses, 13% (11,500) were obese (BMI ≥ 30 kg/m^2) at baseline; 1,334 were extremely obese (BMI ≥ 40). Compared to those of normal weight, the adjusted OR for adult-onset asthma increased from 1.40 (95% confidence interval (CI): 1.31, 1.49) for overweight women to 3.30 (95% CI: 2.85, 3.82) for extremely obese women. Large waist circumference (> 88 cm) was associated with increased asthma prevalence even among women with a normal BMI (OR = 1.37, 95% CI: 1.18, 1.59). Among obese women, the OR for asthma was greater among those who were also abdominally obese compared to women whose waist was ≤ 88 cm (2.36 vs. 1.57). Obese and overweight women were at greater risk of severe asthma episodes, measured by urgent medical visits and hospitalizations. This study confirms the association between excess weight and asthma severity and prevalence, and showed that a large waist was associated with increased asthma prevalence even among women considered to have normal body weight.

MeSH HEADINGS

Asthma; Body Fat Distribution; Body Mass Index; Cohort Studies; Obesity; Prevalence

Obesity has recently been identified as a risk factor for adult asthma, particularly in women [1–4]. Excess abdominal fat may be an important risk factor for asthma, but measures of central obesity have been examined in only a few studies [4–8]. Waist circumference and the waist-to-height ratio closely reflect the amount of visceral fat deposits, which are metabolically different from other body fat [9]. In addition, obesity may increase the severity of asthma [10, 11]. In this analysis, we examined the relationships between several aspects of excess weight and fat distribution, including overall adiposity, abdominal adiposity, and adult weight gain in relation to the prevalence and severity of asthma in a large cohort of women.

MATERIALS AND METHODS

Study Population

The California Teachers Study (CTS) is an ongoing well-described cohort of 133,479 female teachers and school administrators who were employed in the California public school system or retired and receiving retirement benefits at the inception of the cohort in 1995 (40% of the women contacted joined the cohort) [12]. All cohort members completed an extensive baseline questionnaire in 1995–1996. Follow-up questionnaires were administered in 1997, 2000, and 2005. Data of primary relevance to this analysis were height and weight at baseline and at age 18 (all obtained in 1995 in the first questionnaire); waist circumference (collected in 1997); and several asthma-related measures from the 2000 questionnaire, including self-report of physician-diagnosed current asthma, associated symptoms, health-care utilization for asthma symptoms, and age at first asthma diagnosis. Waist circumferences were self-measured based on standardized, validated instructions 13, using a tape measure provided by the researchers. Data on asthma risk factors, including age, race, ethnicity, and smoking exposures, were collected at baseline.

The present analysis included 88,304 women. From the original cohort of 133,479, we excluded women (in a hierarchical manner) as follows: 18 who requested that their survey data only be used for breast cancer research (the original purpose of the study), 3,886 women who died prior to mailing of the 2000 follow-up questionnaire, 40,530 who did not complete the 2000 questionnaire, and 741 who were missing information on asthma. Use of human subject data was approved by the California Committee for the Protection of Human Subjects and the institutional review boards of the participating institutions.

Asthma outcomes

A woman was considered to have current asthma if she answered yes to the question, “Has a doctor ever said that you have asthma?” and reported asthma symptoms that required medication, an urgent visit to a physician’s office or emergency department, or a hospital admission, within the last 12 months prior to completing the questionnaire in 2000. We examined prevalence of current asthma among three groups: all women, those with adult onset, and those with adult onset who were not overweight at age 18. Age of asthma onset was reported in four categories: 0–4 years, 5–18 years, 19–34 years, and ≥ 35 years. We defined adult-onset asthma as that for which a first diagnosis occurred at age 19 or later. Severity of disease was measured by comparing women with current asthma who reported an urgent physician or emergency department visit or hospital admission during the 12 months preceding administration of the 2000 questionnaire compared to those who only used medication during that period.

Measures of body mass and weight gain

Weight and height were reported in pounds, and feet and inches, respectively, and converted to kilograms and meters. Body mass index (BMI) was calculated by dividing weight by height squared. We used BMI categories adopted by the World Health Organization and the National

Institutes of Health: < 18.5 (underweight), 18.5–24.9 (normal weight), 25.0–29.9 (overweight), 30.0–34.9 (obesity, class I), 35.0–39.9 (obesity, class II), and ≥ 40 kg/m^2 (extreme obesity, class III) [14, 15]. We examined BMI at age 18 years and the weight change between age 18 and completion of the baseline questionnaire. Women with BMI values less than 16 or greater than 54.9 were excluded as highly unlikely. A validation study conducted within a subgroup of the CTS showed excellent correlations between self-reported measurements and those obtained by trained interviewers: $r = 0.93$ for height, $r = 0.87$ for weight, $r = 0.87$ for BMI, and $r = 0.85$ for waist circumference (N=317 participants)..

Statistical methods

We examined prevalence odds ratios (ORs) for current asthma by the various measures of body size using logistic modeling (PROC LOGISTIC of SAS version 9)[16]. We included in our models covariates based on prior knowledge of asthma and obesity-related risk factors, including smoking status (current, former, never), a, age (< 40, 40–49, 50–59, 60–69, ≥ 70 years), and race/ethnicity (white, black/African American, Latina, Asian/Pacific Islander, other). As a sensitivity analysis, we repeated the analysis including the women with mild symptoms classified as having current asthma. We also stratified our main analyses by menopausal status (assessed at same time as the asthma symptoms).

RESULTS

Of the 88,304 women eligible for inclusion in the asthma analyses, 13 percent were obese (BMI ≥ 30 at baseline). The overall prevalence of current asthma was 7.6 percent, with 10.9 percent among women in obese class I (BMI 30–34.9 kg/m^2), 13.4 percent among women in obese class II, and 18.3 percent among extremely obese (BMI ≥ 40 kg/m^2) women (Table 1).

In the multivariable models, obesity was strongly associated with an increased prevalence of current asthma (table 2). Compared to those of normal weight, the OR increased from 1.40 (95% confidence interval (CI): 1.31, 1.49) for overweight women to 3.30 (95%CI: 2.85, 3.82) for women with class III obesity. We also found statistically significant positive associations between current asthma prevalence and weight gain since age 18 years, waist circumference, and waist-to-height ratio (Table 2). ORs for the obesity measures were somewhat higher when the analyses were restricted to women with adult-onset asthma as well as those with adult-onset asthma who had not been overweight at age 18 (table 2). When stratified by menopausal status, the odds ratio for BMI and asthma prevalence are somewhat higher among the pre-menopausal women as compared to the post-menopausal women (for the highest category of BMI OR= 3.73 vs. 3.33 for adult onset current asthma).

When BMI was included simultaneously in multivariable models with waist-to-height ratio, both factors remained strongly associated with increased prevalence of current asthma. For example, when modeled together, the OR for extreme obesity was 2.19 (95 % CI: 1.79, 2.66) and the OR for the highest quartile of waist-to-height ratio was 1.75 (95 % CI: 1.56, 1.96).

A waist circumference of greater than 88 cm for women has been classified by the National Institutes of Health [15] as conferring increased disease risk for diabetes, hypertension and cardiovascular disease. As shown in Table 3, when we stratified BMI by this waist circumference cutoff we observed increased asthma prevalence for abdominally obese women even among those of normal weight based on BMI (OR = 1.37, 95 % CI: 1.18, 1.59). Among women who were overweight based on BMI, those whose waist size was less than 88 cm had an adjusted OR of 1.33 (95 % CI: 1.20, 1.47), but those who also had a large waist (> 88 cm) had a OR of 1.67 (95 % CI: 1.51, 1.85). Among women defined as obese, the OR for asthma was greater among those who were also abdominally obese than women whose waist was ≤ 88 cm (2.36 vs. 1.57).

To test the sensitivity of the results to the definition of current asthma used, we repeated the analyses including women with any reported symptoms in the last 12 months, not just symptoms that required medication or medical visits. The overall prevalence of asthma increased from 7.6 percent to 10.9 percent. The adjusted ORs for BMI and the other body size measures were similar to those reported in Table 2. The OR for current adult-onset asthma was 3.69 (95 %CI:3.21, 4.25) for BMI ≥ 40, 2.62 (95 % CI: 2.34, 2.93) for BMI 35–39, 2.02(95 % CI: 1.87, 2.19) for BMI 30 – 34.9, and 1.41 (95 % CI: 1.33, 1.49) for BMI 25–29.9.

Among the 6,713 women with current asthma requiring medication, 704 (10.5 percent) reported an urgent care or emergency department visit and 148 (2.2 percent) reported a hospitalization for asthma in the past 12 months. We categorized women with an urgent care visit, emergency department visit, or hospitalization as having severe asthma. The OR for severe asthma (adjusted for age, race/ethnicity, and smoking) for overweight, obesity (class I and II combined), and extreme obesity were 1.31 (95 %CI: 1.10, 1.56), 1.32 (95% CI: 1.08, 1.62), and 2.00 (95% CI: 1.42, 2.83), respectively (reference group was women of normal weight). Waist circumference and waist to height ratio were also related to severity (for example the OR for highest quartile of waist was 1.59; 95% CI:1.23, 2.06). When both BMI and waist circumference were in the same model the OR for highest BMI was 1.91 (95% CI: 1.17, 3.13) and the OR for highest waist quartile was 1.28 (95% CI: 0.91,1.79).

DISCUSSION

All measures of obesity were strongly associated with increased asthma prevalence. Even being modestly overweight was associated with greater asthma prevalence in this population. In addition, a large waist circumference was associated with modestly increased asthma prevalence among women who were of normal weight based on BMI. These findings are particularly troubling because a majority of American adults are now overweight or obese. The current prevalence of obesity in United States (U.S.) adults is estimated at 32 percent and the prevalence of overweight and obesity combined is 66 percent [17]. Abdominal obesity is increasing faster than overall obesity: according to an analysis of data from the 2003–04 National Health and Nutrition Examination Survey, 61 percent of U.S. women were abdominally obese based on waist circumference 18.

BMI has been widely used as the standard measure of obesity in a variety of health studies, but some researchers have also advocated for the use of waist circumference and the waist-to-height ratio because they more closely reflect visceral fat deposits, which are metabolically different from other body fat [9]. Peripheral fat, deep abdominal subcutaneous fat, and visceral intra-abdominal fat have different effects on the body, with the visceral abdominal fat contributing to a high-risk phenotype that is proinflammatory and prothrombotic [19]. This phenotype has also been linked to insulin resistance and elevated triglyceride levels [19]. Waist circumference and waist-to-height ratio may be better predictors of diabetes and cardiovascular disease risk and are more robust than BMI across ethnic groups, age groups, and between men and women [20–22].

The potential role of central obesity in asthma has been examined in only a few studies. A recent report from Australia indicated that central obesity, measured by both waist circumference and waist-to-hip ratio, was significantly associated with current nonatopic, but not atopic, asthma [7]. A community-based study in Sweden found that both BMI and waist circumference were associated with increased risks for asthma incidence and symptoms, especially in nonatopic patients 6. However, in the Nurses' Health Study, when both BMI and waist-to-hip ratio were included in the same multivariable model, only the point estimates for the BMI categories remained relatively unchanged and statistically significantly associated with increased risk of incident asthma 4. In a recent cross-sectional study of 1,232 adults in

Chile, neither BMI nor waist circumference was associated with asthma symptoms 23. A prospective cohort of French women examined BMI and changes in body silhouettes since menarche [24]. Both high BMI and increases in self-reported body silhouette (a measure of overall size and shape) were strong risk factors for developing asthma as an adult. That study did not report specific measures of abdominal obesity. We also observed weight gain since age 18 years to be statistically significantly associated with increased prevalence of adult asthma symptoms. Overall, the available data seem to suggest that central body fat and weight gain may represent important risk factors for asthma.

Among women with asthma in the CTS cohort, obese and overweight women reported more severe asthma episodes than women of normal weight, as measured by higher proportions of urgent medical visits or hospitalizations. The relationship between severity of asthma and obesity has not been well defined 25. A recent French study reported that BMI was related to asthma severity in women but not men 11. Obese asthmatics who lose large amounts of weight have been shown to experience a reduction in the severity of their asthma symptoms (reviews by Ostrom 26 and Ford 2). In the Nurses' Health Study women with a BMI less than 22.5 were less likely than obese women to report an asthma hospitalization, but the prevalence of asthma medication usage was almost the same in both groups 4.

Asthma may be over-diagnosed in overweight and obese patients because of respiratory symptoms, such as shortness of breath on exertion, that are not actually due to asthma [27]. Data from the third National Health and Nutrition Examination Survey showed that asthma and bronchodilator use were more commonly reported by obese individuals who, however, did not exhibit reduced airflow [27]. There are also several possible mechanisms by which obesity could cause or exacerbate asthma. Obesity is a risk factor for airway hyperresponsiveness [28] and can promote systemic inflammation[25]. Though specific mechanisms linking systemic inflammation with asthma have not yet been convincingly elucidated, it has been hypothesized that obesity can affect the airways via effects on atopy, Th_1-Th_2 lymphocyte ratio, immune responsiveness, lung development, and airway smooth muscle [25]. Obesity is also linked to gastroesophageal reflux disease (GERD), which may be an independent risk factor for adult-onset asthma [25, 29].

Several cross-sectional studies have shown stronger associations between asthma and obesity in women than in men [5, 8, 30–32]. This sex difference suggests that estrogen and other female hormones may be important in asthma etiology, possibly through modulation of Th_2 cytokine production [25]. Obesity may lead to increased levels of estrogen because androgens are converted to estrogens in fatty tissue via increased levels of aromatase and 17-beta hydroxysteroid dehydrogenase [33, 34]. In turn, estrogen may affect airway responsiveness, immune cells or inflammatory processes; however, biological mechanisms have not been elucidated [34].

Our analyses were conducted in a large cohort, with the ability to examine and detect a clear monotonic association with fine categories of BMI, including the category of extreme obesity. We also had several other measures of body size, including waist circumference, that allowed us to assess abdominal obesity, which was associated with increased asthma prevalence even among women of normal weight. However, we did not have information on several recognized risk factors for asthma, including family history of asthma and allergy, exposures to allergens, and early-life respiratory infections; thus, we cannot rule out the possibility of confounding in our results. In addition, because our data were mostly cross-sectional, the temporal relationship between weight gain, obesity onset, and asthma onset is not clear, although we did find that retrospective data on weight gain since age 18 years was associated with adult-onset asthma. In addition, a physician diagnosis of asthma was self-reported and not confirmed by an examination of medical records. While self-reported measures of body composition are also

subject to error [35], a validation study of these measures (excluding weight gain and waist-to-height ratio) conducted in the CTS showed strong correlations between self-report and interviewer-measured assessments. The effects of selection bias or participation bias cannot be ruled out since 30% of the original cohort did not complete the subsequent questionnaire that contained the asthma questions.

In summary, we found statistically significant associations between the prevalence of current asthma and multiple measures of body size and weight gain. Abdominal adiposity appeared to have independent effects on prevalence, separate from BMI. In the next phase of this study, we will prospectively ascertain new asthma cases and will be able to evaluate BMI, waist size, and weight change as risk factors for incident asthma in women.

Acknowledgments

Funding: National Cancer Institute Grant R01 CA77398.

Reference List

1. Beuther DA, Sutherland ER. Overweight, obesity, and incident asthma: a meta-analysis of prospective epidemiologic studies. Am J Respir Crit Care Med 2007;175(7):661–6. [PubMed: 17234901]
2. Ford ES. The epidemiology of obesity and asthma. J Allergy Clin Immunol 2005;115(5):897–909. quiz 910. [PubMed: 15867841]
3. Weiss ST. Obesity: insight into the origins of asthma. Nat Immunol 2005;6(6):537–9. [PubMed: 15908930]
4. Camargo CA Jr, Weiss ST, Zhang S, Willett WC, Speizer FE. Prospective study of body mass index, weight change, and risk of adult-onset asthma in women. Arch Intern Med 1999;159(21):2582–8. [PubMed: 10573048]
5. Del-Rio-Navarro BE, Fanghanel G, Berber A, Sanchez-Reyes L, Estrada-Reyes E, Sienra-Monge JJ. The relationship between asthma symptoms and anthropometric markers of overweight in a Hispanic population. J Investig Allergol Clin Immunol 2003;13(2):118–23.
6. Kronander UN, Falkenberg M, Zetterstrom O. Prevalence and incidence of asthma related to waist circumference and BMI in a Swedish community sample. Respir Med 2004;98(11):1108–16. [PubMed: 15526812]
7. Appleton SL, Adams RJ, Wilson DH, Taylor AW, Ruffin RE. Central obesity is associated with nonatopic but not atopic asthma in a representative population sample. J Allergy Clin Immunol 2006;118(6):1284–91. [PubMed: 17157658]
8. Chen Y, Rennie D, Cormier Y, Dosman J. Sex specificity of asthma associated with objectively measured body mass index and waist circumference: the Humboldt study. Chest 2005;128(4):3048–54. [PubMed: 16236985]
9. Arner P. Not all fat is alike. Lancet 1998;351(9112):1301–2. [PubMed: 9643790]
10. Akerman MJ, Calacanis CM, Madsen MK. Relationship between asthma severity and obesity. J Asthma 2004;41(5):521–6. [PubMed: 15360059]
11. Varraso R, Siroux V, Maccario J, Pin I, Kauffmann F. Asthma severity is associated with body mass index and early menarche in women. Am J Respir Crit Care Med 2005;171(4):334–9. [PubMed: 15557134]
12. Bernstein L, Allen M, Anton-Culver H, et al. High breast cancer incidence rates among California teachers: results from the California Teachers Study (United States). Cancer Causes Control 2002;13(7):625–35. [PubMed: 12296510]
13. Kushi LH, Kaye SA, Folsom AR, Soler JT, Prineas RJ. Accuracy and reliability of self-measurement of body girths. Am J Epidemiol 1988;128(4):740–8. [PubMed: 3421240]
14. World Health Organization. Report on a WHO Conultation. Geneva, Switzerland: World Health Organization; 1997. Obesity: Preventing and Managing the Global Epidemic. WHO Technical Report Series No. 894

15. National Institutes of Health, National Heart, Lung, and Blood Institute. NIH Publication No. 98–4083. Washington, DC, USA: United States Department of Health and Human Services; 1998. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report.
16. Pearce, N. Effect Measures in Prevalence Studies. Vol. 112. 2004. p. 1047-50.
17. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999–2004. JAMA 2006;295(13):1549–55. [PubMed: 16595758]
18. Li C, Ford ES, McGuire LC, Mokdad AH. Increasing trends in waist circumference and abdominal obesity among US adults. Obesity (Silver Spring) 2007;15(1):216–24. [PubMed: 17228050]
19. Despres JP. Is visceral obesity the cause of the metabolic syndrome? Ann Med 2006;38(1):52–63. [PubMed: 16448989]
20. Ashwell M, Hsieh SD. Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. Int J Food Sci Nutr 2005;56(5):303–7. [PubMed: 16236591]
21. Hadaegh F, Zabetian A, Harati H, Azizi F. Waist/height ratio as a better predictor of type 2 diabetes compared to body mass index in Tehranian adult men--a 3.6-year prospective study. Exp Clin Endocrinol Diabetes 2006;114(6):310–5. [PubMed: 16868890]
22. Janssen I, Katzmarzyk PT, Ross R. Waist circumference and not body mass index explains obesity-related health risk. Am J Clin Nutr 2004;79(3):379–84. [PubMed: 14985210]
23. Bustos P, Amigo H, Oyarzun M, Rona RJ. Is there a causal relation between obesity and asthma? Evidence from Chile. Int J Obes (Lond) 2005;29(7):804–9. [PubMed: 15824747]
24. Romieu I, Avenel V, Leynaert B, Kauffmann F, Clavel-Chapelon F. Body mass index, change in body silhouette, and risk of asthma in the E3N cohort study. Am J Epidemiol 2003;158(2):165–74. [PubMed: 12851230]
25. Beuther DA, Weiss ST, Sutherland ER. Obesity and asthma. Am J Respir Crit Care Med 2006;174(2):112–9. [PubMed: 16627866]
26. Ostrom NK. Women with asthma: a review of potential variables and preferred medical management. Ann Allergy Asthma Immunol 2006;96(5):655–65. [PubMed: 16729777]
27. Sin DD, Jones RL, Man SF. Obesity is a risk factor for dyspnea but not for airflow obstruction. Arch Intern Med 2002;162(13):1477–81. [PubMed: 12090884]
28. Shore SA, Fredberg JJ. Obesity, smooth muscle, and airway hyperresponsiveness. J Allergy Clin Immunol 2005;115(5):925–7. [PubMed: 15867846]
29. Simpson WG. Gastroesophageal reflux disease and asthma. Diagnosis and management. Arch Intern Med 1995;155(8):798–803. [PubMed: 7717787]
30. Chen Y, Dales R, Jiang Y. The association between obesity and asthma is stronger in nonallergic than allergic adults. Chest 2006;130(3):890–5. [PubMed: 16963691]
31. Kim S, Camargo CA Jr. Sex-race differences in the relationship between obesity and asthma: the behavioral risk factor surveillance system, 2000. Ann Epidemiol 2003;13(10):666–73. [PubMed: 14599730]
32. Von Behren J, Kreutzer R, Hernandez A. Self-reported asthma prevalence in adults in California. J Asthma 2002;39(5):429–40. [PubMed: 12214897]
33. Pasquali R. Obesity and androgens: facts and perspectives. Fertil Steril 2006;85(5):1319–40. [PubMed: 16647374]
34. Weiss ST, Shore S. Obesity and asthma: directions for research. Am J Respir Crit Care Med 2004;169(8):963–8. [PubMed: 14742299]
35. Kuczmarski MF, Kuczmarski RJ, Najjar M. Effects of age on validity of self-reported height, weight, and body mass index: findings from the Third National Health and Nutrition Examination Survey, 1988–1994. J Am Diet Assoc 2001;101(1):28–34. quiz 35–6. [PubMed: 11209581]

Table 1

Characteristics of the California Teachers Study population and prevalence of current asthma.

	N	Percent of total study subjects	Percent with current asthma
Race/Ethnicity			
White	77,719	88.0	7.5
Black or African American	1,990	2.3	7.6
Hispanic or Latina	3,231	3.7	8.8
Asian or Pacific Islander	3,036	3.4	6.8
Other	2,328	2.6	8.9
Age in 2000–2001 (years)			
< 40	8,551	9.7	8.0
40–49	15,029	17.0	9.0
50–59	25,632	29.0	8.1
60–69	18,039	20.4	7.2
≥ 70	21,053	23.8	6.2
Cigarette smoking			
Never	56,999	64.5	7.5
Former	24,681	28.0	8.1
Current	3,842	4.4	7.2
Unknown	2,782	3.2	6.4
Body Mass Index at baseline (kg/m^2)			
16–18.5 (underweight)	2,156	2.4	6.6
18.5–24.9 (normal weight)	49,533	56.1	6.3
25–29.9 (overweight)	21,657	24.5	8.2
30–34.9 (obese, class I)	7,588	8.6	10.9
35–39.9 (obese, class II)	2,578	2.9	13.4
≥ 40 (obese, class III)	1,334	1.5	18.3
Unknown or out or range	3,458	3.9	7.3
Body Mass Index at age 18 (kg/m^2)			
< 25 (not overweight)	75,362	85.3	7.4
25–29.9 (overweight)	6,290	7.1	8.8
≥ 30 (obese)	2,220	2.5	12.5
Unknown or out or range	4,432	5.0	7.4
Weight gain since age 18			
Lost weight	15,044	17.0	6.7
≤ 25th percentile (< 5 kg)	17,392	19.7	5.8
25 –49th percentile (5 – 10 kg)	17,416	19.7	6.7
50–74th percentile (10.1 –18 kg)	16,146	18.3	7.5
≥ 75th percentile (≥18.1 kg)	18,349	20.8	11.0
Unknown	3,957	4.5	7.2
Percentile* of waist circumference			
≤ 25th percentile (< 72.4 cm)	18,461	20.9	5.9

	N	Percent of total study subjects	Percent with current asthma
25 –49th percentile (72.4–80cm)	18,597	21.1	6.5
50–74th percentile (80.1 –90cm)	16,329	18.5	7.5
≥ 75th percentile (≥90.1 cm)	17,959	20.3	10.0
Unknown or ineligible	16,958	19.2	8.4
Percentile* of waist-to-height ratio			
≤ 25th percentile (≤ 0.441)	17,458	19.8	5.7
25 –49th percentile (0.442–0.484)	17,310	19.6	6.6
50–74th percentile (0.485–0.546)	18,253	20.7	7.2
≥ 75th percentile (≥0.547)	17,605	19.9	10.1
Unknown or ineligible	17,678	20.0	8.3
Total	88,304	100.0	7.6

N = Number (total); kg/m^2 = kilograms per square meter

Percentiles based only on women with non-missing values. Chi-Square p values < 0.01 for all variables.

Table 2

Adjusted* prevalence ratios for body composition and current asthma and adult-onset asthma among California Teachers Study cohort members.

	Current asthma		Adult-onset asthma		Adult-onset asthma among women not overweight at age 18	
	OR*	**95%CI**	**OR***	**95%CI**	**OR***	**95%CI**
Body Mass Index at baseline (kg/m^2)						
< 18.5 (underweight)	1.05	0.88, 1.26	1.00	0.81, 1.24	1.03	0.82, 1.28
18.5–24.9 (normal weight)	1.00		1.00		1.00	
25–29.9 (overweight)	1.40	1.31, 1.49	1.45	1.36, 1.56	1.52	1.41, 1.64
30–34.9 (obese, class I)	1.89	1.73, 2.05	1.97	1.79, 2.16	2.10	1.89, 2.32
35–39.9 (obese, class II)	2.30	2.03,2.59	2.52	2.21, 2.88	2.70	2.30, 3.18
≥ 40 (obese, class III)	3.30	2.85, 3.82	3.66	3.12, 4.30	4.17	3.33, 5.22
Weight gain since age 18						
Lost weight						
≤ 25th percentile (5 kg)	1.00		1.00		1.00	
25 –49th percentile (5 – 10 kg)	1.20	1.10, 1.31	1.20	1.08, 1.33	1.19	1.07, 1.33
50–74th percentile (10.1 –18 kg)	1.34	1.27, 1.52	1.39	1.26, 1.54	1.39	1.25, 1.55
≥ 75th percentile (≥18.1 kg)	2.12	1.96, 2.30	2.22	2.02, 2.44	2.21	2.00, 2.43
Percentile of waist circumference						
≤ 25th percentile (< 72.4 cm)	1.00		1.00		1.00	
25 –49th percentile (72.4–80 cm)	1.17	1.07, 1.28	1.21	1.09, 1.34	1.16	1.05, 1.29
50–74th percentile (80.1 –90 cm)	1.46	1.34, 1.59	1.54	1.39, 1.70	1.49	1.34, 1.66
≥ 75th percentile (≥90.1 cm)	2.01	1.85, 2.18	2.19	1.99, 2.41	2.13	1.92, 2.37
Percentile of waist-to-height ratio						
≤25th percentile (≤ 0.441)	1.00		1.00		1.00	
25 - 49th percentile (0.442–0.484)	1.28	1.17, 1.40	1.38	1.24, 1.53	1.37	1.23, 1.53
50–74th percentile (0.485–0.546)	1.49	1.36, 1.62	1.61	1.45, 1.79	1.59	1.43, 1.77
≥ 75th percentile (≥ 0.547)	2.22	2.04, 2.41	2.51	2.27, 2.77	2.50	2.25, 2.79

N = Number (total); OR = odds ratio; CI = confidence interval; kg/m^2 = kilograms per square meter

*Adjusted for race/ethnicity, age group, and cigarette smoking.

Table 3

Adjustedodds ratios* for adult-onset current asthma by body mass index, stratified by abdominal obesity, among California Teachers Study cohort members.

	Not abdominally obese (waist circumference ≤ 88cm)		Abdominally obese (waist circumference > 88cm)	
	OR	**95% CI**	**OR**	**95% CI**
Body Mass Index (kg/m^2)				
Normal (18.5–24.9)	1.00	reference	1.37	1.18, 1.59
Overweight (25–29.9)	1.33	1.20, 1.47	1.67	1.51, 1.85
Obese (≥ 30)	1.57	1.21, 2.03	2.36	2.15, 2.59

OR = odds ratio; CI = confidence interval; kg/m^2 = kilograms per square meter

*Adjusted for race/ethnicity, age group, and smoking.