

Asthma, obesity, and eating behaviors according to the *Diagnostic and Statistical Manual of Mental Disorders IV* in a large population-based sample of adolescents^{1–3}

David Moreau, Sofia Kalaboka, Marie Choquet, and Isabella Annesi-Maesano

ABSTRACT

Background: Obesity is related to asthma, but factors influencing this relation have not been clearly defined.

Objective: This study was designed to assess the role of eating behaviors and weight concerns in the association between obesity and asthma.

Design: A population-based sample of 11,710 adolescents, recruited from 186 secondary schools of 8 educational districts in France, completed a self-administered standardized questionnaire including DSM IV (*Diagnostic and Statistical Manual of Mental Disorders*) questions on eating disorders.

Results: Obesity (body mass index \geq 95th percentile according to age and sex) was associated with asthma in girls (odds ratio: 1.48; 95% CI: 1.05, 2.08) but not in boys (odds ratio: 1.07; 95% CI: 0.75, 1.54). Both obese and asthmatic adolescents were more likely to have abnormal eating behaviors and weight concerns ($P < 0.05$). In an adjusted polytomous logistic model with 4 categories based on the presence and/or the absence of asthma and obesity as the dependent variable, the odds ratio for weight concerns increased from a minimum value for asthmatic nonobese adolescents (odds ratio: <1.5 ; $P < 0.03$) to a maximum value for asthmatic obese adolescents (odds ratio: >6.3 ; $P < 0.001$) with nonasthmatic, nonobese adolescents as the reference group. Similar patterns were observed for overweight.

Conclusions: Our data suggest that, besides well-known factors such as genetic background, direct mechanical effects, and reduced physical activity, abnormal eating behaviors and weight concerns might intervene in the relation between obesity and asthma. Psychosocial dimension has to be considered to disentangle the complex relation between obesity and asthma in adolescence in view of prevention. *Am J Clin Nutr* 2009;89:1292–8.

INTRODUCTION

Various epidemiologic studies have shown that both asthma and obesity have increased in prevalence in industrialized countries since the 1990s. Furthermore, obesity has been reported to be positively related to asthma (1, 2), although the nature of this link has not been clarified (3, 4). In particular, the factors influencing this relation have not been clearly identified.

Eating behaviors and weight concerns affect obesity, and it cannot be excluded that they might intervene in the association between obesity and asthma. Indeed, eating behaviors and weight

concerns are influenced by hormonal (5) and psychosocial (6) factors, which have also been implicated in the etiology and the progression of asthma. Understanding this interrelation may contribute to the development of effective prevention strategies.

The aim of this study was to explore the interrelations between eating behaviors, weight concerns, asthma, and obesity in a large population-based sample of adolescents recruited in the frame of The National Adolescent Health Survey (NAHS). The NAHS was conducted in France to investigate somatic as well as psychological health and associated risk factors in adolescence (7, 8), among which eating behaviors and weight concerns according to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM IV).

SUBJECTS AND METHODS

Population

A 3-stage selection procedure was used to obtain a representative sample of students in French secondary public school. As a result, 14,278 adolescents were selected from 578 classes in 186 schools of 8 metropolitan educational districts (“Académies” in French), namely those of Strasbourg, Clermont-Ferrand, Nice, Amiens, Créteil, Aix-Marseille, Rennes, and Bordeaux. Students were requested to complete a self-administered standardized questionnaire in the classroom during school time. The protocol was submitted to and approved by the Ethical Committee (Comité National Consultatif d’Ethique) and the Commission Nationale de l’Informatique et des Libertés, the latter to protect the anonymity of the subjects.

¹ From INSERM, Epidemiology of Allergic and Respiratory Diseases, Paris, France (DM, SK, and IA-M); Pierre et Marie Curie University, Epidemiology of Allergic and Respiratory Diseases, Paris, France (DM, SK, and IA-M); and INSERM U669, Maison des Adolescents, Hôpital Cochin, Paris, France (MC).

² Supported by the French Ministry of Education, Direction Générale de la Santé, Fond National de Santé Publique, Mutuelle Générale de l’Education Nationale, and Comité Français d’Education pour la Santé.

³ Reprints not available. Address correspondence to I Annesi-Maesano, Epidemiology of Allergic and Respiratory Diseases, UMR-S 707, INSERM and UPMC-Paris 6, Medical School, Saint Antoine 27 rue Chaligny 75571, Paris CEDEX 12, France. E-mail: annesi-maesano@u707.jussieu.fr.

Received September 10, 2008. Accepted for publication February 20, 2009.

First published online March 25, 2009; doi: 10.3945/ajcn.2008.26954.

Outcomes

Information on asthma, obesity, overweight, eating behaviors, and weight concerns was obtained through a cross-sectional and retrospective assessment by using various standardized questions. Body mass index (BMI), calculated as weight (in kg) divided by height² (in m) as reported through the questionnaire, was used to assess obesity. The accuracy of this assessment was controlled in a subsample of the study population (data not shown). In agreement with previous studies (9, 10), obesity was defined as a BMI \geq 95th percentile according to age and sex and overweight as a BMI \geq 85th percentile according to age and sex. Questions on asthma were based on the enriched version of the International Study of Asthma and Allergies in Childhood questionnaire used and validated in French centers. Asthma was defined by a positive answer to the question "Have you ever had asthma?"

The questionnaire included 5 questions about feeding behaviors in the past year, 4 about weight concerns in the past year and 1 about weight changes in the past year. They were derived by the DSM IV and were previously validated in a case-control study (11). All questions on eating behaviors and 3 of 4 on weight concerns had 4 response options: never, scarcely, often, and quite often. Questions on feeding behaviors in the past year concerned 1) "eating with an appetite," 2) "skipping meals," 3) "dieting," 4) "eating with pleasure," and 5) "eating more when sad." Questions on weight concerns were about 1) "wishing to lose weight," 2) "being afraid of gaining weight," 3) "being worried about weight," and 4) "struggling to maintain or to go back to the desired weight." The latter 3 questions were not asked to children <12 y of age. The question about weight change was as follows: "In the past year my weight has changed a lot." For the analyses, the 4 response options were amalgamated as follows: "never" with "scarcely" and "often" with "quite often."

Confounders

Besides sex and age, socioeconomic factors considered as potential confounders in the relation between asthma and obesity included the following (8): ethnic origin [France, French overseas areas (ie, French West Indies, New Caledonia, French Polynesia, and Reunion Island), northwest Africa (Maghreb in French, ie, Morocco, Algeria, and Tunisia), south and east Europe, and other countries], educational districts (Strasbourg, Clermont-Ferrand, Nice, Amiens, Créteil, Aix-Marseille, Rennes, and Bordeaux), and socioeconomic status (SES) according to father's occupation at the time of the survey. Six branches of occupation were retained as defined by the French Institut National de la Statistique et des Etudes Economiques: skilled agricultural workers, craft and related trades workers and managers, professionals and technicians and associate professionals, clerks, factory workers, retired, and unemployed. Other confounders included tobacco smoking, physical activity, and depressive mood. Questions on smoking were derived from the British Medical Research Council/European Coal and Steel Community questionnaire. Current smoking was defined as smoking cigarettes, pipes, cigarillos, or cigars at the time of the survey, and most adolescents smoked cigarettes. Current smoking was classified in 3 classes: regular heavy smoking (\geq 10 cigarettes/d), regular light smoking (<10 cigarettes/d), and no or occasional smoking. Physical activity con-

sisted of "often" practicing sports outside school. Lastly, depressive mood was assessed with the Kandel and Davies 6-item Kandel Depressive Scale (34). According to their score, adolescents were classified as having low, moderate, or high depressive mood.

Statistical analysis

Pearson's chi-square test was used to assess significant differences in prevalence. Associations between asthma and obesity on one hand and between asthma, overweight status, obesity, and weight changes on the other hand were estimated by logistic regression models allowing for potential confounders and presented as odds ratios. The differential contribution of eating behaviors, weight concerns, and weight changes to the combination of asthma and obesity was assessed by polytomous logistic models through odds ratios. In the latter models, a 4-class variable according to the presence and/or the absence of obesity and asthmatic status, respectively, was used as the dependent variable: 1) nonasthmatic and nonobese adolescents (A-O-), the referent; 2) asthmatic and nonobese adolescents (A+O-); 3) nonasthmatic and obese adolescents (A-O+); and 4) obese and asthmatic adolescents (A+O+). Eating behaviors, weight concerns, and weight changes were considered independent variables as well as the potential confounders. A similar model was assessed with overweight instead of obesity. Interactions between ethnicity and eating behaviors and weight concerns were tested in the polytomous logistic models by including interaction terms. Statistical significance was indicated by *P* values < 0.05. Analyses were carried out by using SAS 8.2 software (SAS Institute Inc, Cary, NC).

RESULTS

Characteristics of the sample

The response rate was 87%, and 11,710 questionnaires contained complete data on asthma and obesity. Of the 11,710 adolescents recruited, 10,960 had full details on ethnic group, smoking habit, and physical activity. Of these, 1,479 did not report any information on SES. There was no significant difference in the prevalence of asthma and obesity between adolescents with missing data and those without. Fewer than 8007 adolescents responded to the last 3 questions about weight concerns, which were not asked to children less than 12 y of age. Characteristics of the study population are shown in **Table 1**. Boys and girls were equally represented in the population. The age distribution was normatively spread with mean and median coinciding at 15 y and the quartiles at 13 and 17 y, respectively. The other characteristics were typical of the conditions of the students of the public secondary school in France according to national statistics.

Prevalence of asthma, overweight, and obesity

Asthma was reported by 11.7% of adolescents, and there were more asthmatic boys (12.7%) than girls (10.5%). In 85% of the adolescents, an asthma diagnosis was confirmed by a physician. Of the 11,710 adolescents, 0.7% were both obese and asthmatic (A+O+), 4.2% only obese (A-O+), and 10.9% only asthmatics (A+O-). Concerning overweight status, 2.0% of adolescents

TABLE 1
Prevalence of ever asthma, overweight, and obesity in relation to individual characteristics in adolescents in France

	Responders	Ever asthma	Overweight	Obesity
	%	%	%	%
Sex (<i>n</i> = 11,710)				
Girls	50.7	10.5	15.0	4.9
Boys	49.3	12.7 ¹	14.9	4.9
Age (<i>n</i> = 11,710)				
8–12 y	17.2	12.0	15.0	4.9
13–14 y	27.6	11.8	14.9	4.9
15–16 y	26.4	11.5	15.0	4.9
17–25 y	28.8	11.3	14.9	4.9
Socioeconomic status (<i>n</i> = 10,083)				
Professionals, technicians, associate professionals	33.7	11.9	11.7	3.6
Clerks	15.8	12.0	14.9	4.4
Factory workers	31.8	10.9	16.4	6.0
Skilled agricultural workers	2.7	9.0	19.9	6.7
Craft and related trades workers, managers	11.3	11.9	16.2	5.1
Unemployed, retired	4.7	9.2	19.4 ²	7.3 ²
Ethnic origin (<i>n</i> = 11,400)				
France	78.1	11.7	14.4	4.6
French overseas area ³	2.3	16.1	17.6	4.2
South and east Europe	8.6	12.4	16.1	6.7
Northwest Africa ⁴	7.6	9.4	18.0	6.6
Other countries	3.5	9.1 ⁵	18.3 ⁵	6.1 ⁵
Smoking habit (<i>n</i> = 11,476)				
Nonsmoker	85.2	11.2	14.8	5.0
Smoker of <10 cigarettes/d	6.2	12.3	14.7	3.9
Smoker of ≥10 cigarettes/d	8.6	15.0 ⁶	16.1	5.6
Physical activity outside school (<i>n</i> = 11,474)				
Scarce	39.2	11.3	17.1	6.4
Often	60.8	11.6	13.5 ⁷	3.9 ⁷

¹ Significantly different from girls, $P < 0.001$ (Pearson's chi-square test).

² Prevalences of overweight and obesity were not evenly balanced across the 6 socioeconomic status, $P < 0.001$ (chi-square test).

³ French overseas departments and territories (French West Indies, Reunion Island, New Caledonia, and French Polynesia).

⁴ Northwest Africa (Morocco, Algeria, and Tunisia).

⁵ Prevalences of asthma, overweight, and obesity were not evenly balanced across the 5 ethnic origins, $P < 0.05$ (chi-square test).

⁶ Prevalence of asthma increased across the 3 categories of smoking habit, $P < 0.05$ (chi-square test).

⁷ Significantly different from scarce physical activity, $P < 0.001$ (Pearson's chi-square test).

were both overweight and asthmatic, 13.0% were only overweight, and 9.7% were only asthmatics.

Prevalence of asthma, overweight, and obesity in relation to potential risk factors

Ethnic origin was related to both asthma and overweight including obesity (Table 1). Adolescents from French overseas areas had the highest prevalence of asthma, whereas those from northwest Africa were the least affected by asthma. Adolescents from northwest Africa and other countries had the highest prevalence of overweight, whereas those from France had the lowest prevalence. The values were different for obesity, because adolescents from south and east Europe had the highest prevalence of obesity, whereas those from French overseas areas had the lowest prevalence. Active smoking was found to be related to asthma. Obesity or overweight and smoking habits were not statistically associated. Conversely, SES was associated with obesity and overweight. Children whose father was unemployed or retired had the highest prevalence of obesity,

whereas children whose father was a professional, an associate professional, or a technician had the lowest prevalence of obesity and overweight. Children whose father was a skilled agricultural worker had the highest prevalence of overweight. Physical activity outside school was also related to obesity. As previously documented, obese and overweight adolescents were less likely to engage in physical activity or practice sports.

Asthma, obesity, overweight, weight change, eating behaviors, and weight concerns

In our population, obesity was significantly associated with asthma in girls but not in boys [odds ratio adjusted for educational district, ethnic origin, smoking habit of 1.48 (95% CI: 1.05, 2.08) compared with 1.07 (95% CI: 0.75, 1.54)]. In both sexes, obese and overweight children as well as asthmatics had experienced more frequent weight changes in the past year (Table 2). As expected, obesity was significantly related to eating behaviors and weight concerns (Table 3). Compared with nonobese adolescents, obese adolescents were less likely to often eat with an

TABLE 2

Relations of weight changes in the past year to ever asthma, overweight, and obesity in adolescents in France, estimated by logistic regression models and presented as adjusted odds ratios (ORs)

	OR ¹	95% CI
Girls (n = 5635)		
Asthma	1.38	1.16, 1.65
Overweight	2.58	2.22, 3.00
Obesity	2.80	2.18, 3.59
Boys (n = 5503)		
Asthma	1.64	1.38, 1.96
Overweight	1.91	1.63, 2.24
Obesity	1.97	1.52, 2.54

¹ Adjusted for educational district, ethnic origin, and smoking habit.

appetite and for pleasure, and they were more likely to often skip meals, to often diet, and to eat more when they were sad. Furthermore, they were much more concerned about their weight than were nonobese adolescents. Similar relations were observed for overweight, although not significantly in the case of often eating with an appetite. Asthma was also significantly related to eating behaviors and weight concerns, although to less of an extent than obesity or overweight (Table 3). Asthmatic adolescents were less likely to often eat with an appetite and for pleasure, and they were more likely to often skip meals, to often diet, and to eat more when they were sad than were nonasthmatics. They were also more concerned about their weight than were nonasthmatic adolescents.

The relations of obesity and asthma to eating behaviors and weight concerns persisted after application of the adjusted polytomous logistic regression model (Figures 1 and 2). Adolescents who reported often skipping meals, dieting, and eating more when they were sad were more likely to be obese (A-O+), asthmatic (A+O-), or both (A+O+) than were non-

asthmatic, nonobese children (Figure 1). Inversely, adolescents who often ate with an appetite or with pleasure were less likely to be asthmatic and obese simultaneously, to be only asthmatic, or to be only obese; nonasthmatic and nonobese adolescents were the referent group.

Adolescents who wished to lose weight in the past year were not only more likely to be obese or asthmatic, although to less of an extent in the latter case (adjusted odds ratio: 1.2), but were also much more likely to be asthmatic and obese simultaneously (adjusted odds ratio: >12) (Figure 2). When considering the other items related to weight concerns, namely "to be afraid of gaining weight," "to be worried about one's weight," and "to struggle to maintain the desired weight," odds ratios increased between categories, from a minimum value for asthmatic nonobese adolescents to a maximum value for adolescents that were both asthmatic and obese. All the odds ratios were statistically significant (Figure 2).

Furthermore, adolescents who experienced weight changes in the past year were more likely to be obese, asthmatic, or both than were those whose weight remained stable (Figure 3). Ethnicity was not found to interact with the relations of obesity and asthma to eating behaviors, weight concerns, and weight changes.

Using the Kandel Depressive Scale, we found that depressive mood was strongly related to eating behaviors and weight concerns and that asthmatic obese adolescents had the highest risk of depressive mood; nonasthmatic and nonobese adolescents were the referent group (data not shown). However, accounting for depressive mood in the adjusted polytomous logistic models did not change the interrelations between obesity, asthma, eating behaviors, and weight concerns (data not shown).

The results remained the same when obesity was replaced by overweight in the polytomous model, ie, adolescents reporting abnormal eating behaviors were more likely to be overweight, asthmatic, or both, and the odds ratio for weight concerns increased from a minimum value for asthmatic nonoverweight

TABLE 3

Percentage prevalence of eating behaviors and weight concerns in the past year in relation to ever asthma, overweight, and obesity in adolescents in France

	Responses		Ever asthma		Overweight		Obesity	
	no.	%	No	Yes	No	Yes	No	Yes
			%		%		%	
Eating behaviors								
To often eat with an appetite	11,656	87.2	87.8	83.2 ¹	87.4	86.6	87.4	84.6 ²
To often skip meals	11,620	15.3	14.6	20.6 ¹	14.6	19.1 ³	15.0	20.5 ⁴
To often diet	11,613	9.2	8.8	12.5 ¹	6.9	22.6 ³	8.2	29.0 ⁴
To often eat with pleasure	11,613	82.4	82.7	79.9 ⁵	83.0	78.9 ³	82.7	76.1 ⁴
To eat more when sad	11,581	26.7	26.1	31.6 ¹	26.0	30.5 ³	26.5	30.4 ²
Weight concerns								
To wish to lose weight	11,676	42.2	41.8	45.1 ⁵	35.7	79.0 ³	39.9	86.3 ⁴
To often be afraid of gaining weight	8007 ⁶	29.2	28.6	33.8 ⁷	26.1	47.2 ³	28.1	50.7 ⁴
To often be worried about one's weight	7983 ⁶	31.4	30.9	35.2 ⁷	27.6	53.1 ³	30.0	58.9 ⁴
To often struggle to maintain desired weight	8006 ⁶	28.4	27.7	33.4 ¹	25.0	47.5 ³	27.2	51.7 ⁴

¹ Significantly different from nonasthmatics, $P < 0.001$ (Pearson chi-square test).

^{2,4} Significantly different from nonobese adolescents (chi-square test): ² $P < 0.05$, ⁴ $P < 0.001$.

³ Significantly different from nonoverweight adolescents, $P < 0.001$ (chi-square test).

^{5,7} Significantly different from nonasthmatics (chi-square test): ⁵ $P < 0.05$, ⁷ $P < 0.01$.

⁶ Questions not asked to children <12 y of age.

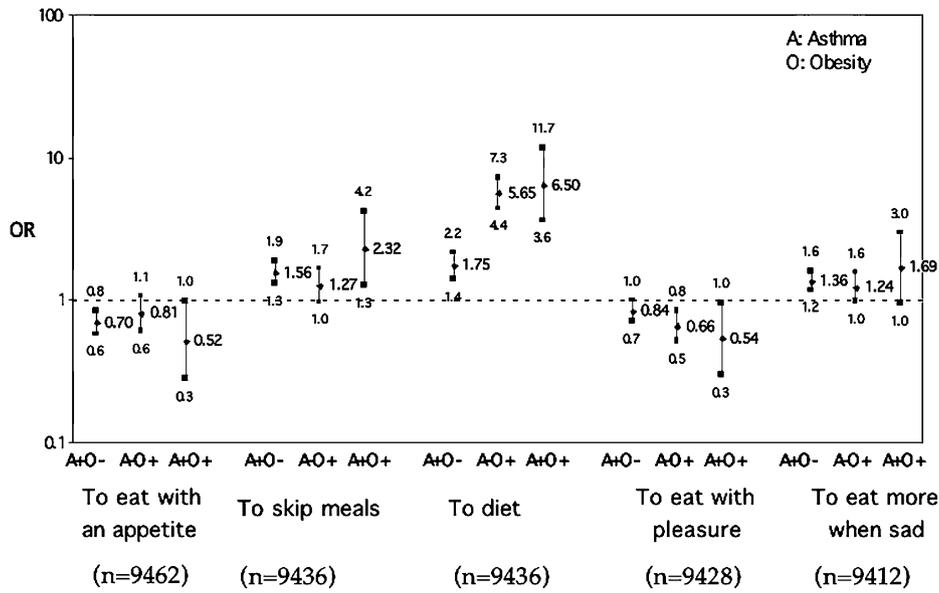


FIGURE 1. Adjusted odds ratios (ORs) and 95% CIs for asthma and obesity according to eating behaviors in the past year in adolescents in France (polytomous logistic models). The ORs were adjusted for sex, educational district, ethnic origin, socioeconomic status, smoking habit, and sports outside school (referent group: nonasthmatic, nonobese adolescents).

adolescents to a maximum value for asthmatic overweight adolescents; nonasthmatic, nonoverweight adolescents were the referent group (Table 4).

DISCUSSION

In the present study, which was carried out in a large population-based sample of adolescents, those with both asthma and obesity were at higher risk than were those with asthma alone, obesity alone, and controls of having abnormal eating behaviors and being concerned about one’s weight as assessed by using the DSM IV. Asthmatic adolescents and obese adolescents were also more likely than others to experience weight changes in

the past year. The results persisted after control for potential confounders known to be related to obesity and asthma and showed the same patterns with overweight instead of obesity.

Although a considerable number of investigations using different study designs have indicated that excess weight might increase the risk of asthma development (1–4, 12–17), this area is still opaque and new options for preventing and treating asthma deserve to be pursued.

There is a large and growing body of literature that stresses the association between asthma and obesity and shows their significant public health effect. A recent review reported data indicating that obesity increases the prevalence, incidence, and possibly severity of asthma, whereas weight loss in obese

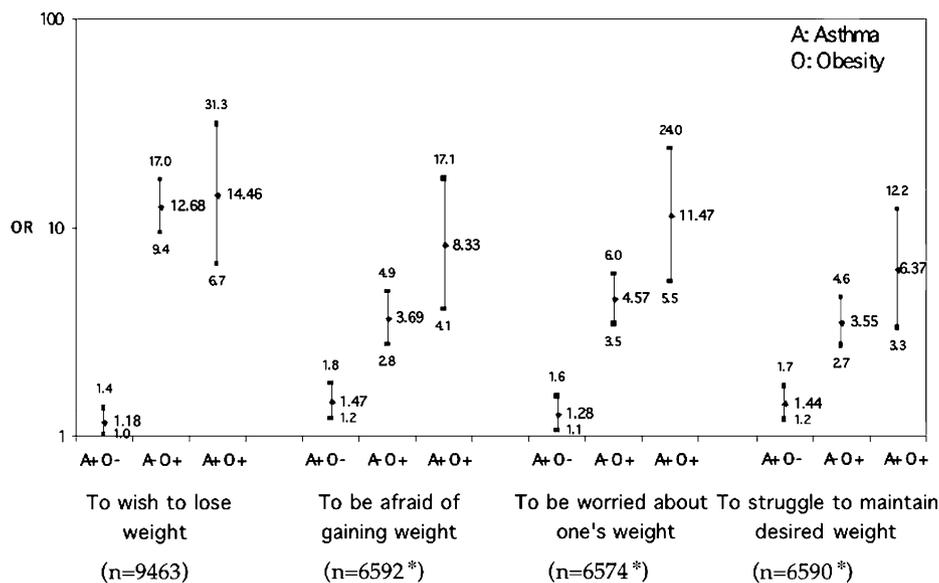


FIGURE 2. Adjusted odds ratios (ORs) and 95% CIs for asthma and obesity according to weight concerns in the past year in adolescents in France (polytomous logistic models). The ORs were adjusted for sex, educational district, ethnic origin, socioeconomic status, smoking habit, and sports outside school (referent group: nonasthmatic, nonobese adolescents). *The questions, except for “to wish to lose weight,” were not asked to children <12 y of age.

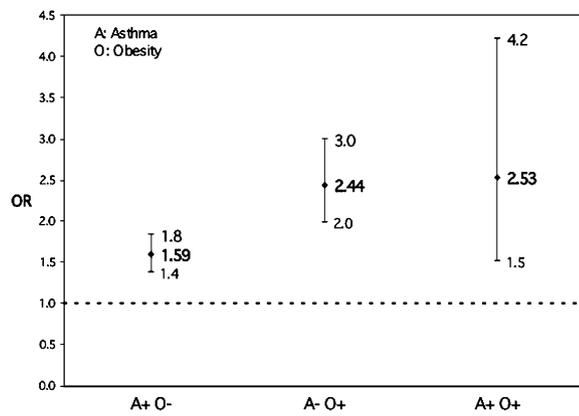


FIGURE 3. Adjusted odds ratios (ORs) and 95% CIs for asthma and obesity according to weight changes in the past year in adolescents in France (polytomous logistic model; $n = 9457$). The ORs were adjusted for sex, educational district, ethnic origin, socioeconomic status, smoking habit, and sports outside school (referent group: nonasthmatic, nonobese adolescents).

individuals improves asthma outcomes (18). Obesity also influences asthma control and the response to standard asthma treatment. The relation between obesity and asthma may be the result of the effects of obesity on lung volume or of the intervention of inflammatory markers and adipokines, such as tumor necrosis factor- α , leptin, and adiponectin. Very recently, the type of adiposity has been associated with airflow obstruction not mediated by airway inflammation (27), and this indicates that there are other potential fields of investigation.

For the first time, our population-based data show that abnormal eating behaviors and weight concerns also intervene in the association between asthma and obesity, which suggests that factors underlying individual behaviors and weight concerns may partially explain the relation between obesity and asthma. These factors include hormonal activity, physiologic mechanisms, and psychological components. Hormones are involved in the regulation of energy intake, eating disorders, and obesity (5). In this context, the role of energy intake has been largely investigated (19). Leptin, by regulating appetite, may influence eating be-

haviors, which in turn may lead to obesity and then weight concerns. Hormone-induced stress has also been shown to interact with immune systems (20), which play a major role in asthma and have been implicated in asthma attacks in children (21). This risk is magnified if the child's life is characterized by multiple chronic stressors. In addition, there are sexual and gender differences in the obesity and prevalence of asthma symptoms and severity (22, 23).

Furthermore, there appears to be a high comorbidity of anxiety disorders and depression in patients with asthma (24, 32), and overweight (25) and asthmatic (26) children have been found to have lower self-esteem than others, just as gaining weight, worrying about one's weight, and struggling to maintain desired weight may induce stress and anxiety (25, 33) known to be related to asthma symptoms (21, 32). In our population-based sample, depressive mood did not seem to explain why asthmatic obese adolescents were at higher risk of eating disturbances and weight concerns because the relations persisted even after adjustment for an objective measurement of it, namely the Kandel's depressive scale.

To our knowledge, this was the first investigation to use the DSM IV to assess eating disorders and weight concerns in a large representative sample of adolescents and to have related it to asthma and obesity. Statistically significant relations were found for both obesity and overweight. Taking into account overweight allowed disposing of larger subsamples for the analysis. Actually, 2.0% of the adolescents were both overweight and asthmatic compared with only 0.7% who were both obese and asthmatic. The fact that overweight adolescents showed the same relations as did obese adolescents supports the hypothesis that eating behaviors and weight concerns were already present in adolescents at risk of obesity and might be predictive of obesity. However, the cross-sectional design prevented an assessment of any causal role for eating behaviors and weight concerns.

Despite the design of the study, an explanatory mechanism relating eating behaviors, obesity, and asthma can be advanced. Lifestyle behaviors such as eating without appetite and pleasure, skipping meals, and being on a diet may lead to an imbalanced nutritional status (5, 28, 29)—a diet of poor nutritious value in

TABLE 4

Adjusted odds ratios (and 95% CIs) for the relation of asthma and overweight status with eating behaviors, weight concerns, and weight changes in the past year in adolescents in France (polytomous logistic models)¹

	Asthmatic, nonoverweight	Nonasthmatic and overweight	Asthmatic and overweight
Eating behaviors			
To often eat with an appetite ($n = 9462$)	0.67 (0.55, 0.81)	0.92 (0.77, 1.10)	0.79 (0.51, 1.24)
To often skip meals ($n = 9436$)	1.60 (1.32, 1.93)	1.37 (1.16, 1.62)	2.05 (1.39, 3.00)
To often diet ($n = 9436$)	1.74 (1.36, 2.23)	4.53 (3.80, 5.40)	7.09 (4.86, 10.3)
To often eat with pleasure ($n = 9428$)	0.82 (0.68, 0.98)	0.75 (0.64, 0.87)	0.70 (0.48, 1.03)
To eat more when sad ($n = 9412$)	1.40 (1.19, 1.64)	1.30 (1.13, 1.50)	1.55 (1.09, 2.21)
Weight concerns			
To wish to lose weight ($n = 9463$)	1.17 (1.00, 1.37)	9.93 (8.45, 11.7)	13.65 (8.95, 20.8)
To often be afraid of gaining weight ($n = 6592$) ²	1.57 (1.27, 1.94)	3.73 (3.12, 4.46)	4.86 (3.14, 7.53)
To often be worried about one's weight ($n = 6574$) ²	1.29 (1.06, 1.58)	3.89 (3.28, 4.61)	6.21 (4.08, 9.43)
To often struggle to maintain desired weight ($n = 6590$) ²	1.51 (1.24, 1.84)	3.31 (2.81, 3.90)	4.38 (2.94, 6.52)
Weight changes ($n = 9457$)	1.56 (1.34, 1.82)	2.21 (1.94, 2.51)	3.36 (2.45, 4.60)

¹ Odds ratios adjusted for sex, educational district, ethnic origin, socioeconomic status, smoking habit, sports outside school (referent group: nonasthmatic, nonoverweight adolescents).

² Questions not asked to children <12 y of age.

terms of antioxidants and rich in total fat—that, in turn, may pave the way not only for overweight and obesity but also for asthma (30, 31). In this context, weight concerns seem to be a simple consequence of eating disorders. The effect of eating behaviors and weight concerns did not differ among ethnicities, which suggests that our results obtained in France remain constant across cultures.

In conclusion, our data confirm previous findings, which suggest that, in addition to direct mechanisms, such as a shared genetic background, hormonal factors, and diminished physical activity, other factors such as abnormal eating behaviors and weight concerns and underlying factors may modulate the obesity-asthma association. The findings further support the hypothesis that the psychosocial dimension may be important to disentangling the complex relation between obesity and asthma during adolescence and strengthen the need to use this dimension in prevention strategies.

We are indebted to the school authorities, the parents, and the adolescents who participated in the survey.

The authors' responsibilities were as follows—DM: participated in the statistical analyses, the data interpretation, and the final writing of the manuscript; SK: participated in the data interpretation and the final writing of the manuscript; MC: designed the survey on the health of the adolescents and collected the data; and IA-M: participated in the design of the study, the collection of the data concerning asthma, the statistical analysis, the interpretation of the data, and the final writing of the manuscript. None of the authors had a financial or personal relationship with an organization that has an interest in the subject of this manuscript, and all authors had access to all the data in the study and approved the final version of the manuscript to be submitted for publication.

REFERENCES

- Flaherman V, Rutherford GWA. Meta-analysis of the effect of high weight on asthma. *Arch Dis Child* 2006;91:334–9.
- Ford ES. The epidemiology of obesity and asthma. *J Allergy Clin Immunol* 2005;115:897–909.
- Chinn S. Obesity and asthma: evidence for and against a causal relation. *J Asthma* 2003;40:1–16.
- Tantisira KG, Weiss ST. Complex interactions in complex traits: obesity and asthma. *Thorax* 2001;56(suppl II):ii64–74.
- Gale SM, Castracane VD, Mantzoros CS. Energy homeostasis, obesity and eating disorders: recent advances in endocrinology. *J Nutr* 2004;134:295–8.
- Steinhausen HC, Gavez S, Winkler Metzke C. Psychosocial correlates, outcome, and stability of abnormal adolescent eating behavior in community samples of young people. *Int J Eat Disord* 2005;37:119–26.
- Choquet M, Ledoux S. Adolescents. *Enquête Nationale*. Paris, France: Les Editions INSERM, 1994.
- Moreau D, Ledoux S, Choquet M, Annesi I. Prevalence and severity of asthma in adolescents in France. Cross-sectional and retrospective analyses of a large population-based sample. *Int J Tuberc Lung Dis* 2000;4:639–48.
- Guillaume M. Defining obesity in childhood: current practice. *Am J Clin Nutr* 1999;70(suppl):126S–30S.
- Malina RM, Katzmarzyk PT. Validity of the body mass index as an indicator of the risk and presence of overweight in adolescents. *Am J Clin Nutr* 1999;70(suppl):131S–6S.
- Ledoux S, Choquet M, Manfredi R. Associated factors for self-reported binge eating among male and female adolescents. *J Adolesc* 1993;16:75–91.
- Beuther DA, Sutherland ER. Overweight, obesity, and incident asthma: a meta-analysis of prospective epidemiologic studies. *Am J Respir Crit Care Med* 2007;175:661–6.
- Beuther DA, Weiss ST, Sutherland ER. Obesity and asthma. *Am J Respir Crit Care Med* 2006;174:112–9.
- Guerra S, Wright AL, Morgan WJ, Sherrill DL, Holberg CJ, Martinez FD. Persistence of asthma symptoms during adolescence: role of obesity and age at the onset of puberty. *Am J Respir Crit Care Med* 2004;170:78–85.
- von Mutius E, Schwartz J, Neas LM, Dockery D, Weiss ST. Relation of body mass index to asthma and atopy in children: the National Health and Nutrition Examination Study III. *Thorax* 2001;56:835–8.
- Shore SA, Johnston RA. Obesity and asthma. *Pharmacol Ther* 2006;110:83–102.
- Chinn S, Rona RJ. Can the increase in body mass index explain the rising trend in asthma in children? *Thorax* 2001;56:845–50.
- Shore SA. Obesity and asthma: implications for treatment. *Curr Opin Pulm Med* 2007;13:56–62.
- Devereux G, Seaton A. Diet as a risk factor for atopy and asthma. *J Allergy Clin Immunol* 2005;115:1109–17.
- Chrousos GP. Stress, chronic inflammation, and emotional and physical well-being: concurrent effects and chronic sequelae. *J Allergy Clin Immunol* 2000;106(suppl):S275–91.
- Sandberg S, Paton JY, Ahola S, et al. The role of acute and chronic stress in asthma attacks in children. *Lancet* 2000;356:982–7.
- Cassol VE, Rizzato TM, Teche SP, et al. Obesity and its relationship with asthma prevalence and severity in adolescents from Southern Brazil. *J Asthma* 2006;43:57–60.
- Shamsain MH. The Association between overweight and respiratory symptoms in schoolchildren. *Pediatr Asthma Allergy Immunol* 2006;19:19–25.
- Janson C, Bjornsson E, Hetta J, Boman G. Anxiety and depression in relation to respiratory symptoms and asthma. *Am J Respir Crit Care Med* 1994;149:930–4.
- Ivarsson T, Svalander P, Litlere O, Nevenon L. Weight concerns, body image, depression and anxiety in Swedish adolescents. *Eat Behav* 2006;7:161–75.
- Seigel WM, Golden NH, Gough JW, Lashley MS, Sacker IM. Depression, self-esteem, and life events in adolescents with chronic diseases. *J Adolesc Health Care* 1990;11:501–4.
- McLachlan CR, Poulton R, Car G, et al. Adiposity, asthma, and airway inflammation. *J Allergy Clin Immunol* 2007;119:634–9.
- Henry BW. The importance of the where as well as what and how much in food patterns of adolescents. *J Am Diet Assoc* 2006;106:373–5.
- Rampersaud GC, Pereira MA, Girard BL, Adams J, Metz J. Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *J Am Diet Assoc* 2005;105:743–60.
- McKeever TM, Britton J. Diet and asthma. *Am J Respir Crit Care Med* 2004;170:725–9.
- Oddy WH, de Klerk NH, Kendall GE, Mihrshahi S, Peat JK. Ratio of omega-6 to omega-3 fatty acids and childhood asthma. *J Asthma* 2004;41:319–26.
- Katon WJ, Richardson L, Lozano P, McCauley E. The relationship of asthma and anxiety disorders. *Psychosom Med* 2004;66:349–55.
- Horner TN Jr, Utermohlen V. A multivariate analysis of psychological factors related to body mass index and eating preoccupation in female college students. *J Am Coll Nutr* 1993;12:459–65.
- Kandel DB, Davies M. Epidemiology of depressive mood in adolescents: an empirical study. *Arch Gen Psychiatry* 1982;39:1205–12.