

## Associations Between Family History of Allergy, Exposure to Tobacco Smoke, Active Smoking, Obesity, and Asthma in Adolescents

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**OBJECTIVE:** The relationships between asthma in adolescents and various environmental and social exposures needs to be clarified. The aim of this study was to determine the association between family history of allergy, passive or active tobacco smoking, obesity, and asthma in adolescents.

**SUBJECTS AND METHODS:** A population-based case-control study was carried out. A random sample of 4003 students aged 13 to 18 years old was selected from secondary and preparatory schools in an urban area in northeastern Mexico. Data was gathered in physical examinations and with a questionnaire administered by trained staff. Two study groups were formed: a group of 253 adolescents with asthma and a control group of students without asthma.

**RESULTS:** Variables associated with asthma were history of allergy (odds ratio [OR], 1.62; 95% confidence interval [CI], 1.28-2.06), passive smoking (OR, 1.53; 95% CI, 1.18-1.99), and obesity (OR, 1.96; 95% CI, 1.45-2.65). Female gender and active smoking were unrelated to asthma. The percentage of obese adolescents was higher in the group of asthmatics (18.2%) than in the control group (12.8%).

**CONCLUSIONS:** Family history of allergy, passive tobacco smoking, and obesity seem to be the main risk factors for the development of asthma in adolescents. The relationship of active smoking and asthma requires further study.

Asociación entre atopía familiar, exposición a humo de tabaco, tabaquismo activo, obesidad y asma en adolescentes

**OBJETIVO:** Es necesario aclarar la relación entre varias exposiciones ambientales y sociales y el asma en la población adolescente. El objetivo de este estudio ha sido determinar la asociación entre la atopía familiar, la inhalación pasiva o activa de humo de tabaco, la obesidad y el asma en adolescentes.

**SUJETOS Y MÉTODOS:** Se ha realizado un estudio de casos y controles basado en un estudio de población. Se encuestó a 4.003 estudiantes de 13 a 18 años de edad, seleccionados aleatoriamente, que acudían a escuelas de secundaria y preparatoria de un área urbana del nordeste de México. La información sobre las variables estudiadas se recabó a través de la exploración física y de la aplicación de un cuestionario por parte de personal capacitado. Se formaron 2 grupos de estudio: uno compuesto por 253 adolescentes con asma, y un grupo control formado por estudiantes sin asma.

**RESULTADOS:** De los resultados se desprende que la atopía familiar (*odds ratio* [OR] = 1,62; intervalo de confianza [IC] del 95%, 1,28-2,06), la exposición involuntaria al humo de tabaco (OR = 1,53; IC del 95%, 1,18-1,99) y la obesidad (OR = 1,96; IC del 95%, 1,45-2,65) se encuentran asociadas con el asma en adolescentes. El sexo femenino y el tabaquismo activo no se relacionan con dicha enfermedad. El porcentaje de obesos fue mayor en el grupo de adolescentes con asma (18,2%) que en el grupo control (12,8%).

**CONCLUSIONES:** La atopía familiar, la inhalación involuntaria de humo de tabaco y la obesidad parecen ser los factores de riesgo más importantes para el desarrollo de asma en adolescentes. La relación entre tabaquismo activo y asma requiere una mejor evaluación.

**Key words:** Atopic hypersensitivity, familial. Tobacco use disorder. Obesity. Asthma. Adolescents.

**Palabras claves:** Atopia familiar. Tabaquismo. Obesidad. Asma. Adolescentes.

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### Introduction

Over the last 2 decades the prevalence of asthma in adolescents has increased alarmingly worldwide and the reasons have not yet been explained satisfactorily.<sup>1,2</sup> Results from studies of the association between asthma

and familial atopic hypersensitivity,<sup>3</sup> smoking,<sup>4,5</sup> and obesity<sup>3</sup> in adolescents have been inconsistent. The discrepancies can be attributed to the research designs used and the complexity of each of the variables considered.

Innumerable studies have shown that genetic factors put a person at considerable risk of developing asthma in childhood.<sup>6</sup> In contrast, the relationship between a family history of allergy and asthma in older persons is debated.<sup>3,7</sup> A review of current literature on the high prevalence of asthma, particularly in adolescents,<sup>8</sup> makes clear that the increase can not be attributed to genetic factors alone.<sup>9</sup> There is an evident need to learn more about the association between environmental and behavioral factors and asthma in adolescents in order to clarify the situation.

For some years, active or passive exposure to tobacco smoke has been related to the development of chronic respiratory diseases,<sup>2,7,10,11</sup> and smoking is currently considered an important public health problem.<sup>12,13</sup> The information available on the association between active smoking and asthma in adolescents is abundant but disparate,<sup>14,15</sup> with some authors showing that smoking puts females but not males at risk for the development of asthma<sup>16,17</sup> and others finding no association at all.<sup>5</sup>

From another standpoint, excess weight and obesity together present the most common nutritional problem of our time<sup>18,19</sup> and are important risk factors for the development of diseases like type 2 diabetes mellitus, heart disease, cerebrovascular disease, cancer, high blood pressure, and respiratory diseases.<sup>20</sup> In recent years the study of the association between obesity and asthma has drawn the attention of many researchers but results to date have been inconclusive.<sup>21-23</sup> Gilliland et al<sup>24</sup> and Chinn et al,<sup>25</sup> among others, have demonstrated a positive association between obesity and asthma but others have not.<sup>26,27</sup> Meanwhile, Mishra,<sup>28</sup> and Tantisira et al<sup>29</sup> identified such an association in women but not in men. Still others suggest the relationship is reversed, that the obesity is caused by the asthma.<sup>30</sup>

The present study was therefore designed to ascertain the relation between a family history of allergy, smoking, obesity, and asthma in a large population sample of adolescents between 13 and 18 years of age who were residents of an urban area in northeastern Mexico. The diagnosis of asthma was made based on uniform criteria. Behavioral, demographic, and socioeconomic factors were recorded.

## Subjects and Methods

A population-based case-control study was carried out. Healthy persons with a diagnosis of asthma between 13 and 18 years old were enrolled. The subjects attended secondary and preparatory schools in an urban area in northeastern Mexico. The area was in the southern part of the state of Tamaulipas, on the coast of the Gulf of Mexico, 542 km northeast of Mexico City: the cities of Tampico, Madero, and Altamira fall within the area, sharing an area of 1492.7 km<sup>2</sup> and a total population of 605 431 inhabitants.

The ethics committee of the Medical Faculty of Tampico, at the Autonomous University of Tamaulipas, Mexico, reviewed and approved the study. Adolescents who participated were recruited through one of the community service programs under the supervision of the Faculty of Medicine. The health care team working in the community was comprised of general practitioners, specialists (allergologists, pneumologists, dermatologists, epidemiologists, and dentists), nurses, teachers, and undergraduate students performing social service projects as part of their medical studies. The permission of the educational authorities in the metropolitan area formed by Tampico, Madero, and Altamira was sought and obtained. Therefore, reliable information was available about the number and location of school inspections in the area, the number and location of schools that supervised each inspection, the number of school shifts, groups and students enrolled in each. The participating schools and students were selected by a simple random sampling technique. In each school selected, a list of enrolled students was requested. Once the lists were obtained, sample students were selected randomly. The dates fell between September 2003 and June 2004.

For data collection, we used a questionnaire based on the one used in the International Study of Asthma and Allergies in Childhood (ISAAC) and the European Community Respiratory Health Survey. To ascertain the level of comprehensibility of the questions, 2 pilot administrations were carried out, 15 days apart; at each piloting, 50 adolescents were interviewed. Agreement was 75%. This instrument also allowed collection of information on age, sex, height, weight, body mass index (BMI), physical activity (type and frequency), number of hours per day watching television or using the internet, family history of allergic diseases, presence of smokers in the home, active smoking habit (frequency and age of onset), diagnosed asthma, asthma symptoms, severity and treatment, and personal history of allergy.

Once the questionnaire was created and validated, it was administered in 2 piloting sessions with interviewers who were trained in how to gather the information, particularly with regard to diagnosis of asthma and other variables taken into consideration in the analysis.

The World Health Organization (WHO) defines 3 different periods of adolescence: preadolescence (10-14 years), adolescence properly speaking (14-18 years), and late adolescence (19-24 years). Young persons between the ages of 13 and 18 years were enrolled.

Height was measured on a stature meter with shoes removed and head, neck, spine, and knees in neutral position. The soles of the feet were firmly placed on the horizontal surface. A platform scale calibrated before each turn was used to weigh the adolescents, who were standing relaxed and dressed in light clothing. Weight was rounded to the nearest 100 g. BMI was calculated by dividing weight in kilograms by height in meters squared (kg/m<sup>2</sup>). The adolescents were classified following WHO recommendations as obese when their BMI was more than 30 kg/m<sup>2</sup>.

A parental history of allergy was recorded if either parent had a history of allergic asthma or rhinitis. Adolescents were considered active smokers if they answered affirmatively to the first question (Do you smoke?) in part A of the questionnaire (Appendix). Information on asthma was obtained with questions 1 through 6 of part B. An adolescent was classified as having asthma if he or she responded affirmatively to question 1 (Has a doctor ever said that you have asthma?), question 2 (Have you had an asthma attack in the last 12 months?), and question 3 (Has your doctor ordered

a spirometric test for you?); alternatively, asthma was reported if the subject answered affirmatively to questions 4 (Have you used any medication for asthma in the past year?) and 5 (Have you noticed wheezing in your chest in the last year?) The respondent was considered to have asthma symptoms if an affirmative answer was given to questions 5 and 6 (Did your medications relieve the wheezing?)

The parents or guardians' oral and written consent to the adolescent's participation was obtained.

#### Statistical Analysis

Data were analyzed with the SPSS software package, version 13.0, to calculate simple frequencies and measures of central tendency (mean [SD]) for each group. A 2x2 contingency table was constructed, a  $\chi^2$  test was applied, and odds ratios (OR) and 95% confidence intervals (CI) were calculated to determine the risk of presenting asthma or asthma symptoms in relation to family history of allergy, passive or active smoking, and obesity. The interactions among the main variables were determined by multiple regression analysis.

## Results

We studied 4003 adolescents (49.1% males) with a mean age of 14.29 (1.51) years. A diagnosis of asthma by a doctor was reported by 6.3%, and 6.1% had symptoms related to asthma. Females were slightly more numerous in the sample as a whole and in the groups of patients with diagnosed asthma or complaining of asthma symptoms. Table 1 shows the personal and clinical characteristics of the study population by sex.

A family history of allergy was reported by 1327 adolescents (mother, 19.6%; father, 13.6%); 66.8% reported that neither parent was allergic. The presence of smokers in the home while the participant was growing up was reported by 21.5%. The father was most often identified as the smoker (58.74%). Active smoking was reported by 116; the percentage of smokers was higher in the group of asthmatics (3.6%) than among the controls (2.9%), and males smoked more (3.3%) than females (2.6%). Forty-four percent of the adolescents had a BMI within the normal range, 42.9% were overweight, and 13.1% were obese. Females were more often overweight than males (43.4% vs 42.3%, respectively). Higher percentages of obese individuals were observed among adolescents with diagnosed asthma (18.2% obese among cases vs 12.8% obese among controls) and adolescents with asthma symptoms (15.3% obese among symptomatic responders vs 12.7% obese among controls). Obesity was more frequent among males (15.7%) than females (10.6%).

The population was distributed in 2 groups consisting of 253 adolescents with asthma and another group of controls without asthma. Demographic, anthropometric, and clinical parameters were compared between the 2 groups. Table 2 shows the prevalence of asthma, obesity, and other clinical and demographic characteristics of cases and controls.

More adolescents diagnosed with asthma had parents with allergic asthma or rhinitis (8.5% of the asthmatics

TABLE 1  
Personal and Clinical Characteristics of the Study Population, by Gender\*

	Males	Females
Total population, n=4003	1967	2036
Age, y	14.2 (1.4)	14.3 (1.5)
Weight, kg	55.7 (15.9)	51.9 (12.7)
Height, m	1.5 (0.1)	1.5 (0.0)
BMI, kg/m <sup>2</sup>	21.8 (5.3)	21.2 (4.7)
Normal, 18.5-24.9	825 (41.9%)	936 (46.0%)
Overweight, 25-29.9	833 (42.3%)	884 (43.4%)
Obese, ≥30.0	309 (15.7%)	216 (10.6%)
Family history of allergy	594 (30.0%)	733 (36.0%)
Smokers at home	443 (22.5%)	418 (20.5%)
Active smoking	64 (3.3%)	52 (2.6%)
Wheezing in past year	91 (4.6%)	154 (7.6%)
Diagnosed asthma	126 (6.4%)	127 (6.2%)
Use of inhaled bronchodilator	211 (10.7%)	262 (12.9%)

\*Data are expressed as mean (SD) or absolute number (%). BMI indicates body mass index.

TABLE 2  
Prevalence of Diagnosed Asthma, Obesity, and Other Clinical and Demographic Characteristics of Cases and Controls\*

	Cases	Controls
Population	253	3750
Sex		
Males	126 (49.8%)	1841 (49.1%)
Females	127 (50.2%)	1909 (50.1%)
Age, y	14.0 (1.3)	14.3 (1.5)
Weight, kg	55.2 (14.1)	53.6 (14.5)
Height, m	1.5 (0.9)	1.5 (0.1)
BMI, kg/m <sup>2</sup>	21.9 (12.7)	21.5 (5.0)
Normal, 18.5-24.9	100 (39.5%)	1661 (44.3%)
Overweight, 25-29.9	107 (42.3%)	1610 (42.9%)
Obese, ≥30.0	46 (18.2%)	479 (12.8%)
Family history of allergy	113 (44.7%)	1214 (32.4%)
Smokers at home	75 (29.6%)	786 (21.0%)
Active smoking	9 (3.6%)	107 (2.9%)
Wheezing in past year	78 (30.8%)	167 (4.5%)
Hospital visit	67 (26.5%)	116 (3.1%)

\*Data are expressed as mean (SD) or absolute number (%). BMI indicates body mass index.

vs 5.2% of the controls). A family history of allergy put adolescents at risk of asthma (OR, 1.62; 95% CI, 1.28-2.06;  $P < .01$ ). A higher rate of asthma (8.7%) was found in the group of adolescents who reported living with smokers than in the group living with nonsmokers (5.7%). The effect of the presence of smokers in the home on asthma in adolescents was significant (OR, 1.53; 95% CI, 1.18-1.99;  $P < .01$ ). Likewise, obesity had a certain effect on asthma (8.8% of obese and 6.0% of nonobese adolescents had asthma; OR, 1.47; 95% CI, 1.08-1.99;  $P < .01$ ). Active smoking was unrelated to having a diagnosis of asthma. Table 3 shows the effect of family history of allergy, smoking, and obesity on adolescent asthma.

A family history of allergy was also related to having asthma symptoms in these adolescents (8.7% with a family history vs 4.8% without such a history were

TABLE 3  
Influence of Gender, Family History of Allergy, Passive or Active Smoking, and Obesity on Adolescent Asthma\*

	Diagnosed With Asthma (n=253), n (%)	Controls (n=3750), n (%)	OR (95% CI)	P
Males	126 (6.4)	1841 (93.6)	1.02 (0.80-1.30)	NS
Females	127 (6.2)	1909 (93.8)		
Family history of allergy			1.62 (1.28-2.06)	<.01
Yes	113 (8.5)	1214 (91.5)		
No	140 (5.2)	2536 (94.8)		
Smokers at home			1.53 (1.18-1.99)	<.01
Yes	75 (8.7)	786 (91.3)		
No	178 (5.7)	2964 (94.3)		
Active smoker			1.23 (0.65-2.34)	NS
Yes	9 (7.8)	107 (92.2)		
No	244 (6.3)	3643 (93.7)		
Obesity			1.47 (1.08-1.99)	.01
Yes	46 (8.8)	479 (91.2)		
No	207 (6.0)	3271 (94.0)		

\*CI indicates confidence interval; NS, not significant; OR, odds ratio.

TABLE 4  
Influence of Gender, Family History of Allergy, Passive or Active Smoking, and Obesity on Asthmatic Symptoms in Adolescents\*

	Asthmatic Symptoms (n=245), n (%)	Controls (n=3758), n (%)	OR (95% CI)	P
Males	91 (4.6)	1876 (95.4)	0.62 (0.47-0.78)	<.01
Females	154 (7.6)	1882 (92.4)		
Family history of allergy			1.81 (1.42-2.31)	<.01
Yes	116 (8.7)	1211 (91.3)		
No	129 (4.8)	2547 (95.2)		
Smokers at home			1.93 (1.50-2.49)	<.01
Yes	85 (9.9)	776 (90.1)		
No	160 (5.1)	2982 (94.9)		
Active smoking			1.72 (0.99-2.99)	NS
Yes	12 (10.1)	104 (87.7)		
No	233 (6.0)	3654 (94.0)		
Obesity			0.99 (0.69-1.42)	NS
Yes	32 (6.1)	493 (93.9)		
No	213 (6.1)	3265 (93.9)		

\*CI indicates confidence interval; NS, not significant; OR, odds ratio.

symptomatic; OR, 1.81; 95% CI, 1.42-2.31;  $P<.01$ ). Likewise, the presence of smokers in the home influenced probability of having asthma symptoms (9.9% of those living with smokers vs 5.1% of those living with nonsmokers were symptomatic; OR, 1.93; 95% CI, 1.50-2.49;  $P<.01$ ). Male gender seemed to protect against having asthma symptoms in adolescence (OR, 0.62; 95% CI, 0.47-0.78;  $P<.01$ ). Active smoking with 10.1% of smokers vs 6.0% of nonsmokers symptomatic (OR, 1.72; 95% CI, 0.99-2.99;  $P$ =not significant [NS]) and obesity with 6.1% of both obese and nonobese adolescents symptomatic (OR, 0.99;  $P$ =NS) were unrelated to risk of having asthma symptoms. Table 4 shows the effect of family history of allergy, smoking, and obesity on asthma symptoms in adolescents.

Multivariate regression analysis showed that having parents with a history of allergy and living with smokers were independent risk factors for having a diagnosis of asthma and symptoms of asthma. Obesity had an effect on risk of diagnosed asthma and

female gender affected risk of asthma symptoms. Each variable that maintained significance was studied separately.

## Discussion

Epidemiological surveys, such as the ISAAC study,<sup>1</sup> have been used for some time to gather information on respiratory diseases. However, findings based on self-reporting in response to such questionnaire surveys should be interpreted cautiously because of the possibility of inaccuracy or bias.<sup>2,8</sup> The questionnaire used in this study was based on the previously cited projects. The robustness of the results is supported by the fact that interviewers were trained to apply consistent criteria when recording information about demographic and behavioral variables, when conducting the physical examination, and when taking measurements. The criteria for identifying adolescents with a diagnosis of asthma established by a physician and/or symptoms of asthma were similarly consistent.

However, it is important to point out that although we were careful to identify cases in accordance with design procedures, the diagnosis of asthma was unconfirmed by spirometry or bronchial challenge testing.

Numerous studies have shown that a family history of allergy is an important risk factor for the development of asthma in childhood. The association between such a history and asthma in adolescence is debated, however. Certain authors, such as Sears et al,<sup>7</sup> have found that a family history of allergy increases risk of asthma in older individuals. However, Rhodes et al<sup>3</sup> found no association. Another recent study showed that certain genetic traits that are common to obesity and asthma may explain the association between these disorders.<sup>23</sup> Our findings support the hypothesis that a family history of allergy increases risk of asthma, as the risk of an asthma diagnosis in the adolescent respondents in our study with such a family history was higher in comparison with controls by a factor of 1.62 (95% CI, 1.28-2.06;  $P<.01$ ). Their risk of symptoms was also higher, with an OR of 1.81 (95% CI, 1.42-2.31;  $P<.01$ ). The higher rate of obesity (18.6%) among asthmatic adolescents who had a family history of allergy in comparison with those whose parents were not allergic (17.7%) also merits mention.

Passive or active smoking is an important risk factor for respiratory diseases. The adverse effect of smoking on the airways has been well documented in the literature,<sup>10</sup> and passive smoking has been associated with childhood asthma.<sup>6</sup> However, the relation of smoking to asthma in adolescence is debated.<sup>3,16</sup> Our results, unlike those of Rhodes et al,<sup>3</sup> demonstrated an association between the presence of smokers in the adolescents' homes and both asthma ( $P<.01$ ) and asthmatic symptoms ( $P<.01$ ).

Active smoking is currently a significant health problem in the adolescent population. An association between active smoking and adolescent asthma remains unclear. Certain authors, such as Chen et al,<sup>16</sup> among others,<sup>17</sup> have only been able to find an association between smoking and asthma in females, whereas other have found no correlation.<sup>5</sup> We are aware that the percentage of adolescents who reported smoking in this study (a prevalence of 2.9%) is smaller than that reported by other authors, such as Annesi-Maesano et al<sup>4</sup> (prevalence of 9.3%). A selection bias should therefore be taken into account when interpreting the results, which can not be generalized to all adolescents. We consider that a large number of adolescents did not report their smoking because authorities in the Mexican schools they attended and the subjects' parents forbade it under threat of punishment if the rule is broken. This is particularly the case for adolescents with chronic respiratory disease. However, we can base certain conjectures on a comparison of our findings with those of other studies. We found no association between smoking and asthma ( $P=NS$ ), an observation that is probably due to the aforementioned selection bias. It is noteworthy, however, that like other authors,<sup>4,13</sup> we observed higher rates of smoking among asthmatics than among healthy controls. With regard to gender

differences, more female (3.9%) than male asthmatics (3.2%) smoked.

At present, findings from studies of the relationship between obesity and asthma are inconsistent. Von Mutius,<sup>11</sup> Mishra,<sup>28</sup> and Gennuso et al<sup>30</sup> found that obesity increases the risk of asthma for children and adolescents, whereas Sin et al<sup>27</sup> found no association and others have reported an association for only one sex.<sup>16,24</sup> Furthermore, information available on the relations among obesity, asthma, and gender in adolescence is not very convincing. It is known that asthma increases among females during adolescence and that the ratio of males to females with the disease changes from 2:1 during childhood to a more even balance during adolescence. In adults, the proportion of women who are asthmatics is twice that of men. It is important to remember these patterns because there is some suggestion that female hormones might play a direct or indirect role in a causal relationship between obesity and asthma.<sup>16,20</sup> Other authors have shown that asthma symptoms, but not bronchial hyperreactivity, increase with obesity, and they have speculated that anatomical changes in the upper airway may be responsible.<sup>26</sup> Our results show that obese adolescents have a risk of asthma that is 1.47 (95% CI, 1.08-1.99;  $P<.01$ ) times that of nonobese adolescents. We observed no association between obesity and asthmatic symptoms ( $P=NS$ ). In our study population, there were more obese male adolescents with asthma (15.39%) than females (12.7%), observations that are consistent with those of Gilliland et al,<sup>24</sup> but different from those of Chen et al.<sup>16</sup>

In conclusion, understanding the relationship between asthma and factors such as family history of allergy, and exposure to tobacco smoke can be important for establishing strategies to limit the negative effects of the disease. Family history of allergy is clearly the most important risk factor for developing either asthma or asthmatic symptoms and should be borne in mind when establishing preventive programs. Based on our findings and a review of the current literature, we conclude that exposure to tobacco smoke and obesity also increase risk to a certain extent. This is important to remember because both factors are related to lifestyle and can be modified in a positive way, with great benefits for the population in general.

## REFERENCES

1. Fagan JK, Scheff PA, Hryhorezuk D, Ramakrishnan V, Ross M, Persky V. Prevalence of asthma and other allergic diseases in an adolescent population: association with gender and race. *Ann Allergy Asthma Immunol.* 2001;86:177-84.
2. Carvajal-Ureña I, García-Marcos L, Busquets-Monge R, Suárez-Varela MM, de García NA, Batllés-Garrido J, et al. Variaciones geográficas en la prevalencia de síntomas de asma en los niños y adolescentes españoles. International Study of Asthma and Allergies in Childhood (ISAAC) fase III España. *Arch Bronconeumol.* 2005;41:659-66.
3. Rhodes HL, Sporik R, Thomas P, Holgate ST, Cogswell JJ. Early life risk factors for adult asthma: a birth cohort study of subjects at risk. *J Allergy Clin Immunol.* 2001;108:720-5.

4. Annesi-Maesano I, Orszyszyn MP, Raheison C, Kopferschmitt C, Pauli G, Taytard A, et al. Increased prevalence of asthma and allied diseases among active adolescent tobacco smokers after controlling for passive smoking exposure. A cause for concern? *Clin Exp Allergy*. 2004;34:1017-23.
5. Thomsen SF, Ulrik CS, Kyvik KO, Larsen K, Skadhauge LR, Steffensen I, et al. The incidence of asthma in young adults. *Chest*. 2005;127:1928-34.
6. Björkstén BB, Kjellman N-IM, Zeiger RS. Development and prevention of allergic disease in childhood. In: Middleton E, Reed CE, Ellis EF, Adkinson NF, Yunyinger JW, Busse WW, editors. *Middleton's allergy principles and practice*. 5th ed. New York: Mosby; 1998. p. 816-37.
7. Sears MR, Greene JM, Willan AR, Wiecek EM, Taylor DR, Flannery EM. A longitudinal, population-based, cohort study of childhood asthma followed to adulthood. *N Engl J Med*. 2003;349:1414-22.
8. Maziak W, Behrens T, Brasky TM, Duhme H, Rzehak P, Weiland SK. Are asthma and allergies in children and adolescents increasing? Results from ISAAC phase 111 surveys in Münster, Germany. *Allergy*. 2003;58:572-9.
9. Valero A, Serrano C. Are environmental controls effective for house-dust-mite allergies? *Arch Bronconeumol*. 2004;40:389-91.
10. Patel DR, Homnick DN. Pulmonary effects of smoking. *Adolesc Med*. 2000;11:567-76.
11. von Mutius E. The environmental predictors of allergic disease. *J Allergy Clin Immunol*. 2000;105:9-19.
12. Romero PJ. Asma y humo de tabaco. *Arch Bronconeumol*. 2004;40:414-8.
13. Zbikowski SM, Klesges RC, Robinson LA, Alfano CM. Risk factors for smoking among adolescents with asthma. *J Adolesc Health*. 2002;30:279-87.
14. Zimlichman E, Mandel D, Mimouni FB, Shochat T, Grotto I, Kreiss Y. Smoking habits in adolescents with mild to moderate asthma. *Pediatr Pulmonol*. 2004;38:193-7.
15. Hansen PD, Keiding L, Madsen M. Smoking patterns among adolescents with asthma attending upper secondary schools: a community-based study. *Pediatrics*. 2003;111:562-8.
16. Chen Y, Dales R, Krewski D, Breithaupt K. Increased effects of smoking and obesity on asthma among female Canadians: the National Population Health Survey, 1994-1995. *Am J Epidemiol*. 1999;150:255-62.
17. Larsson L. Incidence of asthma in Swedish teenagers: relation to sex and smoking habits. *Thorax*. 1995;50:260-4.
18. Stein C, Colditz GA. The epidemic of obesity. *J Clin Endocrinol Metab*. 2004;89:2522-5.
19. Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and trends in overweight among US children and adolescents, 1999-2000. *JAMA*. 2002;288:1728-32.
20. Daniels SR, Arnett DK, Eckel RH, Gidding SS, Hayman LL, Kumanyika S, et al. Overweight in children and adolescents. Pathophysiology, consequences, prevention, and treatment. *Circulation*. 2005;111:1999-2012.
21. Bustos P, Amigo H, Oyarzún M, Rona RJ. Is there a causal relation between obesity and asthma? Evidence from Chile. *Int J Obes*. 2005;29:804-9.
22. Bua J, Prescott E, Schack-Nielsen L, Petersen L, Godtfredsen NS, Sorensen TIA, et al. Weight history from birth through childhood and youth in relation to adult lung function, in Danish juvenile obese and non-obese men. *Int J Obes*. 2005;29:1055-62.
23. Tantisira KG, Weiss ST. Complex interactions in complex traits: obesity and asthma. *Thorax*. 2001;56 Suppl 11:62-74.
24. Gilliland FD, Berhane K, Islam T, McConnell R, Gauderman WJ, Gilliland S, et al. Obesity and the risk of newly diagnosed asthma in school-age children. *Am J Epidemiol*. 2003;158:406-15.
25. Chinn S, Jarvis D, Burney P. Relation of bronchial responsiveness to body mass in the ECRHS. *Thorax*. 2002;57:1028-33.
26. Schachter LM, Salome CM, Peat JK, Woolcock AJ. Obesity is a risk for asthma and wheeze but not airway hyperresponsiveness. *Thorax*. 2001;56:4-8.
27. Sin DD, Jones RL, Man P. Obesity is a risk factor for dyspnea but not for airflow obstruction. *Arch Intern Med*. 2002;162:1477-81.
28. Mishra V. Effect of obesity on asthma among adult Indian women. *Int J Obes*. 2004;28:1048-58.
29. Tantisira KG, Litonjua AA, Weiss ST, Fuhlbrigge AL. Association of body mass with pulmonary function in the childhood asthma management program. *Thorax*. 2003;58:1036-41.
30. Gennuso J, Epstein L, Paluch RA, Cerny F. The relationship between asthma and obesity in urban minority children and adolescents. *Arch Pediatr Adolesc Med*. 1998;152:1197-200.

APPENDIX

**Questionnaire for Interviewing Adolescents**

*Part A*

1. Do you smoke?
  - Yes
  - No
2. How often do you smoke?
  - Every day
  - At least once a week
  - Only on special occasions
3. When did you start to smoke? \_\_\_\_\_
4. How much do you smoke? Please write the approximate number of cigarettes you smoke
  - Every day \_\_\_\_\_
  - Every week \_\_\_\_\_

*Part B*

1. Has your doctor ever said you have asthma?
  - Yes
  - No
2. Have you had an asthma attack in the last 12 months?
  - Yes
  - No
3. Has your doctor ever ordered a spirometric test for you?
  - Yes
  - No
4. Have you used any medication for asthma in the past year?
  - Yes
  - No

Please write the names of the medicines you use regularly to control your asthma.

\_\_\_\_\_
5. Have you noticed wheezing in your chest in the past year?
  - Yes
  - No
6. Did your medication relieve the wheezing?
  - Yes
  - No