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.1,2 Results from studies of the association between asthma and several factors are consistent with the idea that asthma is a multifactorial disease, in which the role of allergens, tobacco smoke, obesity, and other factors must be considered.3,4 However, the exact contribution of these factors to asthma development is not known.1,2

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.

Key words: Atopic hypersensitivity, familial. Tobacco use disorder. Obesity. Asthma. Adolescents.
In contrast, the relationship between a family history of allergy and asthma in older persons is debated. A review of current literature on the high prevalence of asthma, particularly in adolescents, makes clear that the increase cannot be attributed to genetic factors alone. 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, but smoking is currently considered an important public health problem. The information available on the association between active smoking and asthma in adolescents is abundant but disparate, with some authors showing that smoking puts females but not males at risk for the development of asthma and others finding no association at all.

From another standpoint, excess weight and obesity together present the most common nutritional problem of our time 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. 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. Gilliland et al and Chinn et al, among others, have demonstrated a positive association between obesity and asthma but others have not. Meanwhile, Mishra and Tantsira et al 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.

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 km² 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 health care service programs under the supervision of the Faculty of Medicine. The health care team working in the community 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 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/m²). The adolescents were classified following WHO recommendations as obese when their BMI was more than 30 kg/m².

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. Information was obtained with questions 1 through 6 of part B. An adolescent was classified as having asthma if he or she responded affirmatively to any of the questions 1 Has your doctor ordered...
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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 χ² 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 (44.7% of the asthmatics vs 44.5% of the controls). The presence of smokers in the home while the participant was growing up was reported by 29.6%; 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 (15.3%) 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 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<0.01). 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<0.01). 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<0.01). 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 symptomatic responders vs 4.8% without such a history were asymptomatic responders).

**TABLE 1**

<table>
<thead>
<tr>
<th></th>
<th>Cases</th>
<th>Controls</th>
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</thead>
<tbody>
<tr>
<td>Total</td>
<td>126 (49.8%)</td>
<td>1909 (50.1%)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>126 (49.8%)</td>
<td>1841 (49.1%)</td>
</tr>
<tr>
<td>Females</td>
<td>127 (50.2%)</td>
<td>1909 (50.1%)</td>
</tr>
<tr>
<td>Age, y</td>
<td>14.0 (1.3)</td>
<td>14.3 (1.5)</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>55.2 (14.1)</td>
<td>53.6 (14.5)</td>
</tr>
<tr>
<td>Height, m</td>
<td>1.50 (0.9)</td>
<td>1.50 (0.1)</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>21.9 (12.3)</td>
<td>21.3 (5.6)</td>
</tr>
<tr>
<td>Normal, 18.5-24.9</td>
<td>100 (39.5%)</td>
<td>1661 (44.3%)</td>
</tr>
<tr>
<td>Overweight, 25-29.9</td>
<td>107 (42.3%)</td>
<td>1630 (42.9%)</td>
</tr>
<tr>
<td>Obese, 30.0</td>
<td>46 (18.2%)</td>
<td>479 (12.8%)</td>
</tr>
<tr>
<td>Family history of allergy</td>
<td>115 (44.4%)</td>
<td>1214 (32.3%)</td>
</tr>
<tr>
<td>Smokers at home</td>
<td>75 (29.6%)</td>
<td>786 (21.0%)</td>
</tr>
<tr>
<td>Active smoking</td>
<td>9 (3.6%)</td>
<td>107 (2.9%)</td>
</tr>
<tr>
<td>Wheezing in past year</td>
<td>78 (30.9%)</td>
<td>167 (45.5%)</td>
</tr>
<tr>
<td>Hospital visit</td>
<td>67 (26.5%)</td>
<td>116 (31.9%)</td>
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**TABLE 2**

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<thead>
<tr>
<th></th>
<th>Cases</th>
<th>Controls</th>
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</thead>
<tbody>
<tr>
<td>Prevalence of Diagnosed Asthma, Obesity, and Other Clinical and Demographic Characteristics of Cases and Controls*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>253</td>
<td>3750</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
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<tr>
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<thead>
<tr>
<th></th>
<th>Cases</th>
<th>Controls</th>
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</thead>
<tbody>
<tr>
<td>Use of inhaled bronchodilator</td>
<td>211 (10.7%)</td>
<td>262 (12.9%)</td>
</tr>
</tbody>
</table>

Data are expressed as mean (SD) or absolute number (%). BMI indicates body mass index.
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; 95% CI, 0.69-1.42; 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, 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. 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 asthma and allergy in adolescence is debated, however. Certain authors, such as Sears et al., have found that a family history of allergy increases risk of asthma, whereas others have found no association between asthma and allergy in adolescence. However, this study (a prevalence of 2.9%) is smaller than that reported by other authors, such as Annesi-Maesano et al., and is consistent with those of Gilliland et al., 23, 24 and Mutius, 25 and Cennuso et al., 26 who found no association. Another recent study showed that genetic traits that are common to obesity and asthma may explain the association between these disorders. 27 Our findings support the hypothesis that a family history of allergy increases risk of asthma, as the risk of 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, 28 and passive smoking has been associated with childhood asthma. 29 However, the relation of smoking to asthma in adolescence is debated. 29-31 Our results, unlike those of Rhodes et al., 32 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., 33 among others, 34-36 have only been able to find an association between smoking and asthma in females, whereas other authors have found no correlation. 37 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 Annessi-Maesano et al., 38 (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 consistent with those of Gilliland et al., 23 and from those of Chen et al. 39

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 evaluating the problem. 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

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 week  ☐ Every day

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

5. Have you noticed wheezing in your chest in the past year?
   ☐ Yes  ☐ No

6. Did your medication relieve the wheezing?
   ☐ Yes  ☐ No

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