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# Asthma in schoolchildren from Recife, Brazil. Prevalence comparison: 1994-95 and 2002

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**Abstract**

**Objectives:** To describe the prevalence of asthma and asthma variants in schoolchildren from Recife in 2002, and to compare these data with data from 1994-95; to analyze the relationship between maternal schooling and the presence of asthma or worsening asthma; and to evaluate the diagnostic accuracy of the yearly prevalence of wheezing as an asthma indicator.

**Methods:** Cross-sectional study. A probabilistic sample of 3,086 and 2,774 13- and 14-year-old students answered a written questionnaire in 1994-95 and 2002, as part of the International Study of Asthma and Allergies in Childhood.

**Results:** The following prevalence rates were observed in 1994-95 and 2002, respectively: cumulative prevalence of referred asthma: 21 *vs* 18.2%; cumulative prevalence of wheezing: 39 *vs* 38%; yearly prevalence of wheezing: 19.7 *vs* 19.4%; yearly prevalence of night cough: 31 *vs* 38%; yearly prevalence of exercise-induced wheezing: 20.6 *vs* 23.8%. The yearly prevalence of asthma attacks was 16.3 *vs* 15.2% for 1 to 3 attacks; 2.7 *vs* 1.2% for 4 to 12 attacks; and 1 *vs* 0.4% for more than 12 attacks. The yearly prevalence of attacks that disturbed sleep was 13 and 10.3%. The yearly prevalence of attacks with compromised speech was 4.8 and 4.1%. Higher levels of maternal schooling were related to higher cumulative prevalence of referred asthma and to cumulative and yearly prevalence of wheezing.

**Conclusions:** The prevalence of asthma and its severe forms is high in teenager students in Recife. It is also related to higher levels of maternal schooling.

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## Introduction

Asthma is a chronic inflammatory disease of the airways, predominantly eosinophilic, which results in a recurrent obstruction of the airflow, reversible spontaneously or in response to therapy. Atopic disease is the most frequently identified predisposing factor.[1-4] It constitutes a public health problem, as much for its prevalence as for its morbidity.[5-9]

During phase one of ISAAC, (International Study of Asthma and Allergies in Childhood), 463,801 13 and 14 year-old adolescents and 257,800 children aged 6 and 7 years of age, from 56 countries were studied by questionnaire. The average cumulative prevalence of asthma reported was 11.3%, varying from 1.4 to 30.4%. Brazil was eighth in the ranking.[5] This project investigated 20,544 schoolchildren aged 13-14 years and 13,604 aged 6-7 years, in Curitiba, Itabira, Recife, Salvador, São Paulo, Porto Alegre and Uberlândia. In the first group, the reported prevalence of asthma was 9.8% for males and 10.2% for females. In the 6-7 year-old group, it was 7.3 and 4.9%, respectively.[6] In Recife, the ISAAC data from 1994-95 for 1,410 schoolchildren aged 6 and 7 years and 3,086 pupils aged 13 and 14 years old, demonstrated a reported asthma prevalence of 20.4 and 19.7%, respectively.[7]

Further Brazilian studies using methods similar to those of the ISAAC project have also been performed recently. In schoolchildren from Uberlândia aged 6 and 7

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and 13 and 14, the prevalence of asthma was 15 and 16.8%, respectively.[10] Camargos et al.,[11] studying 13 and 14 year-old adolescents in provincial Minas Gerais, found a reported cumulative asthma prevalence of 27%. In Itabira and Santa Maria, cities in Minas Gerais state, a reported prevalence of asthma of 4.6% was observed in schoolchildren.[12] Chatkin,[8] found a prevalence of 25.4% in a cohort from the city of Pelotas in 1997-98.

In addition to the point-by-point assessments, the comparison of different periods allows tendencies to be detected in the variation of prevalence. In the United States between 1963 and 1980, in children from 6 to 11 years of age, the reported prevalence of asthma increased from 5.3 to 7.6%.[13] In England, Burney et al.,[14] studying children from 4 to 12 years of age, demonstrated an increase in prevalence of 6.9% among boys and 12.8% among girls, between 1973 and 1986. In Scotland, Upton et al.[15] studying 1,447 couples in 1972 and 1,124 adults descendents in 1996, found that prevalence had doubled. In Melbourne, the prevalence of reported asthma increased for the 7 year-old subset from 19.1 to 46% between 1964 and 1990.[16] Shaw et al.,[17] studying adolescents in New Zealand observed an increase in the prevalence of reported asthma or wheezing from 26.2 to 34.0%, in the period from 1975 to 1989.

Asthma and socioeconomic conditions: the relationship between the two is not clear. According to Rona,[18] there is not sufficient evidence to associate poverty as an etiologic factor in asthma. Nevertheless, the numbers of urgent cases, hospitalizations and deaths are linked to this variable. In Brazil relational studies have been contradictory and rare.

The objectives of this study were to: describe the current prevalence of asthma and its variants in schoolchildren from the city of Recife, to compare prevalence for the periods 1994-1995 and 2002, to analyze any relationship with the extent of maternal education and to evaluate the diagnostic accuracy of the annual prevalence of wheezing as an indicator of asthma.

## Method

A population-based, cross-sectional study was performed in Recife with adolescents de 13 and 14 years of age, composed of two surveys, one in 1994-95 and the other in 2002.

Recife is a coastal city in the Northeast of Brazil, with an area of 2,200 km$^2$ and 1,296,996 inhabitants, of whom 48% are poor (*per capita* income less than half a minimum national wage). The average temperature is 25.3 ºC, varying from 23.2 to 26.5 ºC. Humidity is between 72 and 86%.[19] The metropolitan region produces the following air pollutants monthly: 1,000 tons of airborne particles, 351 tons of sulphur dioxide, 45 tons of nitrous oxide, 33 tons of hydrocarbons and 336 tons of carbon monoxide.[20] According to the IBGE 2000 census, 40.8% of the inhabitants of Recife aged more than 20 years had not completed four years' schooling.[21]

Both the sample of schoolchildren from 1994-95 and that from 2002 were selected in a probabilistic manner. The Recife Municipal Education Authority provided the seventh and eighth grade roll (in which grades students aged 13-14 years are to be found), according to type – public (state, municipal, federal) and private, with the number of students in these grades per school. Lots were drawn in such a manner as to preserve distribution by type. Schools with less than 10 students were excluded and those with large numbers participated with a maximum of 200 schoolchildren.

For the sample size calculation, initial asthma prevalence was assumed to be 20%, with an annual increase or decrease of 0.5%, a power of 80% and significance level of 5%, resulting in a requirement for 1967 subjects per survey, although in the event an attempt was made to obtain 3,000 schoolchildren per survey, as specified by the ISAAC project.

The instrument employed had been developed for the ISAAC project, using closed responses, designed for auto-administration by the students and previously validated in São Paulo.[22] The only changes made to this instrument were: 1. Add the degree of maternal education item. 2. Where the original questionnaire referred to "wheezing", this was translated as: *chiado no peito (cansaço, sibilos, piado)* [roughly translated, "wheezes in chest (fatigue, whistling, crackling)"], since it is common to refer to episodes of asthma as "fatigue" in our locale.

Both surveys were entered onto their databases using double-input. Statistical analysis was performed with Epi Info 2002 and Win Episcope 2.0. Pearson's association chi-square and chi-square for tendencies were used. Significance cutoff was set at 5%. For the diagnostic accuracy evaluation, tests of sensitivity, specificity, positive and negative predictive values and the Youden index were used with 95% confidence intervals.

Each school principal signed a free and informed consent form before inclusion in the study. The study was approved by the IMIP Committee for Ethics in Research.

## Results

In 1994-95, 97.6% of the questionnaires were returned and 100% in 2002. On both occasions one private school refused to take part and was excluded from the sample.

The proportion of public schools had increased between the two surveys. In 1994-95 this figure was 65% and in 2002 it was 74.6% ($p < 0.001$).

In 1994-95 1,656 13 year-old students and 1,431 14 year-old students were studied, making a total of 3,086 schoolchildren. Of these 1,392 (45.1%) were male and 1,694 (54.9%) female. In 2002, 1,428 of the 2,774 questionnaires were from 13 year-olds and 1,346 from 14 year-olds. Distribution by sex was similar: 1,238 (44.6%) males and 1,536 (55.4%) females.

The distribution of maternal educational level is shown in Figure 1. There was a significant reduction in the level of maternal schooling in the 2002 survey ($p < 0.001$). The

level of illiteracy was 7.2 and 10.7% for the two occasions, respectively. Basic elementary school had not been completed by 32.3 as against 46.2%, respectively.

In Table 1 the cumulative annual prevalence of wheezing can be observed. There was no significant difference in prevalence between 1994-95 and 2002 in either variable, even when grouped or stratified by sex.

The annual prevalence of night cough and exercise triggered wheezing can also be seen in Table 1. There was a significant increase in night cough in 2002 (31 *versus* 38%, Pearson's chi-square, $p < 0.001$). In a similar manner the prevalence of wheezing triggered by exercise increased from 20.6% in 1994-95 to 23.8% in 2002.

The cumulative reported prevalence of asthma (Table 2) was 21% in 1994-95 and 18.2% in 2002. There was a significant reduction in prevalence, when the two periods were compared. The first survey revealed a male predominance (Pearson's chi-square, $p < 0.001$), in contrast with 2002 (Pearson's chi-square, $p < 0.918$). Taking the values by type of school, it is observed that the prevalence at public schools had dropped from 24.8 to 15% and at the private schools had risen from 16.1 to

Questionnaire of prevalence for schoolchildren aged 13-14 years | No. _____

School: _____ Date: _____ /_____ /_____

Name: _____ Age: _____

Home address: _____

Phone number: _____ Sex: ( ) Male ( ) Female

What is your mother's educational level?

( ) Elementary school ( ) Incomplete elementary school ( ) High school ( ) Incomplete high school

( ) College ( ) Has never attended school

1) Have you ever had wheezes in the chest (fatigue, whistling, crackling)?

( ) Yes ( ) No

➧ **If your answer was NO, go to question no. 6.**

2) Have you had wheezes in the chest (fatigue, whistling, crackling) in the last 12 months?

( ) Yes ( ) No

3) How many crises of wheezes in the chest (fatigue, whistling, crackling) have you had in the last 12 months?

( ) None ( ) 1 to 3 crises ( ) 4 to 12 crises ( ) More than 12 crises

4) How many times the wheezes in the chest (fatigue, whistling, crackling) have disturbed your sleep in the last 12 months?

( ) The wheezing crises never disturbed my sleep ( ) Less than 1 night a week ( ) 1 or more nights a week

5) The wheezing crises (fatigue, whistling, crackling) were severe enough to cause speaking difficulties in the last 12 months?

( ) Yes ( ) No

6) Have you ever suffered from asthma?

( ) Yes ( ) No

7) Have you have wheezes in the chest (fatigue, whistling, crackling) after practicing physical exercises in the last 12 months?

( ) Yes ( ) No

8) Have you had nocturnal cough without having a cold or a respiratory infection in the last 12 months?

( ) Yes ( ) No

**Figure 1 -** Questionnaire of prevalence for students aged 13-14 years-old

**Table 1 -** Cumulative annual prevalence of wheezing, annual prevalence of night cough, without having a cold or a respiratory infection, and exercise triggered wheezing in students aged 13 and 14 years-old (Recife, 1994-95 and 2002)

| | Period | | | | | |
|---|---|---|---|---|---|---|
| | 1994-95 | | | 2002 | | |
| | Sex | | | Sex | | |
| **Wheezing at any time in their life** | **Male n (%)** | **Female n (%)** | **Total * n (%)** | **Male n (%)** | **Female n (%)** | **Total * n (%)** |
| Present | 582 (41.8) | 619 (36.6) | 1,201 (38.9) ‡ | 468 (37.8) | 578 (37.6) | 1,046 (37.7) § |
| Unanswered | 3 (0.2) | 2 (0.1) | 5 (0.2) | 12 (1.0) | 11 (0.7) | 23 (0.8) |
| Total | 1,392 (100) | 1,693 (100) | 3,085 (100) | 1,238 (100) | 1,536 (100) | 2,774 (100) |
| **Wheezing in the last 12 months** | **Male n (%)** | **Female n (%)** | **Total † n (%)** | **Male n (%)** | **Female n (%)** | **Total † n (%)** |
| Present | 300 (21.5) | 307 (18.1) | 607 (19.7) ¦ | 231 (18.6) | 299 (19.4) | 530 (19.1) ¶ |
| Unanswered | 1 (0.1) | 0 (0) | 1 (0) | 17 (1.4) | 18 (1.2) | 35 (3.3) |
| Total | 1,392 (100) | 1,694 (100) | 3,086 (100) | 1,238 (100) | 1,536 (100) | 2,774 (100) |
| **Night cough in the last 12 months** | **Male n (%)** | **Female n (%)** | **Total ** n (%)** | **Male n (%)** | **Female n (%)** | **Total ** n (%)** |
| Present | 390 (28.0) | 563 (33.2) | 953 (30.9) †† | 400 (32.3) | 633 (41.2) | 1,033 (37.2) ‡‡ |
| Unanswered | 5 (0.4) | 8 (0.5) | 13 (0.4) | 23 (1.9) | 34 (2.2) | 57 (2.1) |
| Total | 1,392 (100) | 1,694 (100) | 3,086 (100) | 1,238 (100) | 1,536 (100) | 2,774 (100) |
| **Wheezing after exercise in the last 12 months** | **Male** | **Female** | **Total §§** | **Male** | **Female** | **Total §§** |
| Present | 258 (18.5) | 373 (22.0) | 631 (20.4) ¦¦ | 276 (22.3) | 365 (23.8) | 641 (23.1) ¶¶ |
| Unanswered | 7 (0.5) | 11 (0.6) | 18 (0.6) | 32 (2.6) | 50 (3.1) | 82 (3.0) |
| Total | 1,392 (100) | 1,694 (100) | 3,086 (100) | 1,238 (100) | 1,536 (100) | 2,774 (100) |

* Considering total of both periods and excluding those who did not answer: Pearson's $\chi^2$, p = 0.447.
† Considering total of both periods and excluding those who did not answer: Pearson's $\chi^2$, p = 0.754.
‡ Excluding those who did not answer: prevalence = 39% (95%CI = 37.2-40.7%).
§ Excluding those who did not answer: prevalence = 38% (95%CI = 36.2-39.9%).
¦ Excluding those who did not answer: prevalence = 19.7% (95%CI = 18.3-21.1%).
¶ Excluding those who did not answer: prevalence = 19.4% (95%CI = 17.9-20.9%).
** Considering total of both periods and excluding those who did not answer: Pearson's $\chi^2$, p < 0.001.
†† Excluding those who did not answer: prevalence = 31% (95%CI = 29.4-32.7%).
‡‡ Excluding those who did not answer: prevalence = 38% (95%CI = 36.2-39.9%).
§§ Considering total of both periods and excluding those who did not answer: Pearson's $\chi^2$, p = 0.003.
¦¦ Excluding those who did not answer: prevalence = 20.6% (95%CI = 19.2-22.1%).
¶¶ Excluding those who did not answer: prevalence = 23.8% (95%CI: 22.2-25.5%).
Source: ISAAC project.

28.9% (p < 0.001 in both cases). A similar pattern is seen for both sexes in this cut.

The annual frequency of episodes of wheezing is listed in Table 3. Comparing the up to three crises subset with the four or more crises group, it is observed that the percentage in the larger number of crises group was significantly greater in 1994-95, when compared with 2002 (Pearson's chi-square, p < 0.001).

Table 3 also details annual frequency of wheezing crises with lost sleep or difficulty speaking. Taking both sexes, the frequency of wheezing affecting sleep was significantly greater in 1994-95 (Pearson's chi-square, p = 0.004), in contrast with crises compromising speech which was at 4.8% on the first occasion and 4.1% in 2002 (no significant difference).

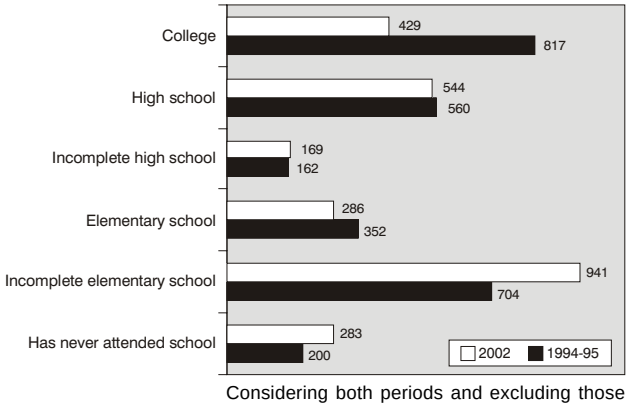
Looking at the reported cumulative asthma prevalence in terms of maternal education (Table 4), a significant tendency to greater frequency was observed in the categories with more schooling, both in 1994-95 and in 2002. The annual prevalence of wheezing by maternal education presented in a similar manner (Table 4). Taking the number of wheezing crises per year by level of maternal education (Table 4), a significant trend to exhibit four or more crises was observed the more educated the mother during the 1994-95 survey. This trend was not found in 2002.

**Table 2 -** Cumulative reported prevalence of asthma in students aged 13 and 14 years-old, showing the values by type of school and the total values (Recife, 1994-95 and 2002)

| Type of school | Asthma reported at any time in their life | Period | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1994-95 | | | 2002 | | |
| | | Sex | | | Sex | | |
| | | Male n (%) | Female n (%) | Total * n (%) | Male n (%) | Female n (%) | Total * n (%) |
| Public | Present | 214 (28.1) | 192 (21.3) | 406 (24.4) † | 122 (13.1) | 195 (16.2) | 317 (14.8) ‡ |
| | Unanswered | 15 (2.0) | 12 (1.3) | 27 (1.6) | 13 (1.4) | 16 (1.3) | 29 (1.4) |
| | Total | 761 (100) | 901 (100) | 1,662 (100) | 933 (100) | 1,207 (100) | 2,140 (100) |
| Private | Present | 98 (17.0) | 104 (14.9) | 202 (15.8) § | 100 (32.8) | 83 (25.2) | 183 (28.9) ¦ |
| | Unanswered | 6 (1.0) | 13 (1.9) | 19 (1.5) | 1 (0.3) | 0 (0) | 1 (0.2) |
| | Total | 577 (100) | 698 (100) | 1,275 (100) | 305 (100) | 329 (100) | 634 (100) |
| Both | Present | 326 (23.4) | 317 (18.7) | 643 (20.8) ¶ | 222 (17.9) | 278 (18.1) | 500 (18.0) ** |
| | Unanswered | 13 (0.9) | 10 (0.6) | 23 (0.7) | 14 (1.1) | 16 (1.0) | 30 (1.1) |
| | Total | 1,392 (100) | 1,694 (100) | 3,086 (100) | 1,238 (100) | 1,536 (100) | 2,774 (100) |

* Considering total of both periods and excluding those who did not answer: Pearson's $\chi^2$, $p < 0.001$ for public schools, $p < 0.001$ for private schools and $p = 0.008$ for both types.
† Excluding those who did not answer: prevalence = 24.8% (95%CI = 22.8-27%).
‡ Excluding those who did not answer: prevalence = 15% (95%CI = 13.5-16.6%).
§ Excluding those who did not answer: prevalence = 16.1% (95%CI = 14.1-18.3%).
¦ Excluding those who did not answer: prevalence = 28.9% (95%CI = 25.4-32.6%).
¶ Excluding those who did not answer: prevalence = 21% (95%CI = 19.6-22.5%).
** Excluding those who did not answer: prevalence = 18.2% (95%CI = 16.8-19.7%).
The addition result of the number of students of public and private schools in 1994-95 is lower than the total for both types because the type of school was not obtained in a small percentage of questionnaires. Source: ISAAC project.

In Table 5 the number of wheezing crises per year that disturbed sleep or compromised speech is shown by maternal education. There were no observed tendencies linking the two variables in either 1994-95 or 2002.




Considering both periods and excluding those who did not answer: Pearson's $\chi 2$ , $p < 0.001$. Source: ISAAC Project.

**Figure 2 -** Maternal educational level of students aged 13 to 14 years-old (Recife, 1994-95 and 2002)

The association between annual wheezing and reported asthma can be observed in Table 6. For both the reported cumulative asthma prevalence of 21% in 1994-95, and that of 18.2% in 2002, observed sensitivity and positive predictive values are low and specificity and negative predictive value are high for the annual wheezing prevalence. The Youden index was low for both surveys.

## Discussion

The cumulative prevalence of reported asthma in Recife was elevated in both surveys. In phase 1 of ISAAC, Brazil was eighth in the ranking out of 56 countries studied. Five Brazilian state capitals were included in phase one, of these Recife exhibited the second greatest prevalence.[23] In Latin America, variations in prevalence were related with climatic conditions. Hot and humid climates (characteristics that Recife has) are associated with greater prevalence.[24]

The reduction in asthma prevalence reported in Recife differs from international studies,[10,11,15-17] in which the opposite has occurred. In Brazil results are divergent. Fiore et al.[25] analyzing schoolchildren in Porto Alegre, found an increase in the prevalence of the symptoms of asthma and atopic disease. Wandalsen,[26] studying pupils in São Paulo in 1995 and 1999, found an increase in the

**Table 3 -** Number of wheezing crises in the last 12 months and the number of crises in the last 12 months that affected sleep and compromised speech of students aged 13 and 14 years-old (Recife, 1994-95 and 2002)

| | Period | | | | | |
|---|---|---|---|---|---|---|
| | 1994-95 | | | 2002 | | |
| | Sex | | | Sex | | |
| **Number of crises in the last 12 months** | **Male n (%)** | **Female n (%)** | **Total * n (%)** | **Male n (%)** | **Female n (%)** | **Total * n (%)** |
| None | 1,093 (78.5) | 1,376 (81.2) | 2,469 (80.0) | 1,029 (83.1) | 1,259 (82.0) | 2,288 (82.5) |
| 1 to 3 | 248 (17.8) | 253 (14.9) | 501 (16.3) † | 184 (14.9) | 233 (15.2) | 417 (15.1) ‡ |
| 4 to 12 | 33 (2.4) | 50 (3.0) | 83 (2.7) † | 13 (1.0) | 21 (1.4) | 34 (1.2) ‡ |
| More than 12 | 17 (1.2) | 15 (0.9) | 32 (1.0) † | 5 (0.4) | 7 (0.4) | 12 (0.4) ‡ |
| Unanswered | 1 (0.1) | 0 (0) | 1 (0) | 7 (0.6) | 16 (1.0) | 23 (0.8) |
| Total | 1,392 (100) | 1,694 (100) | 3,086 (100) | 1,238 (100) | 1,536 (100) | 2,774 (100) |
| **Number of crises affecting sleep in the last 12 months** | **Male n (%)** | **Female n (%)** | **Total § n (%)** | **Male n (%)** | **Female n (%)** | **Total § n (%)** |
| None | 1,191 (85.6) | 1,490 (88.0) | 2,681 (86.9) | 1,111 (89.7) | 1,350 (87.9) | 2,461 (88.7) |
| < 1 a week | 134 (9.6) | 126 (7.4) | 260 (8.4) ¦ | 80 (6.5) | 95 (6.2) | 175 (6.3) ¶ |
| ≥ 1 a week | 63 (4.5) | 77 (4.5) | 140 (4.5) ¦ | 34 (2.7) | 73 (4.7) | 107 (3.9) ¶ |
| Unanswered | 4 (0.3) | 1 (0.1) | 5 (0.2) | 13 (1.1) | 18 (1.2) | 31 (1.1) |
| Total | 1,392 (100) | 1,694 (100) | 3,086 (100) | 1,238 (100) | 1,536 (100) | 2,774 (100) |
| **Number of crises compromising speech in the last 12 months** | **Male n (%)** | **Female n (%)** | **Total ¶¶ n (%)** | **Male n (%)** | **Female n (%)** | **Total ¶¶ n (%)** |
| Present | 74 (5.3) | 74 (4.4) | 148 (4.8) ** | 39 (3.1) | 73 (4.7) | 112 (4.0) †† |
| Unanswered | 2 (0.1) | 0 (0) | 2 (0.1) | 6 (0.5) | 15 (1.0) | 21 (0.8) |
| Total | 1,392 (100) | 1,694 (100) | 3,086 (100) | 1,238 (100) | 1,536 (100) | 2,774 (100) |

* Considering total of both periods and excluding those who did not answer: Pearson's $\chi^2$, $p < 0.001$.
† Excluding those who did not answer: prevalence = 16.3; 2.7; and 1% (95%CI = 15-176%; 2.2-3.3%; and 0.7-1.5%), respectively.
‡ Excluding those who did not answer: prevalence = 15.2; 1.2; and 0.4% (95%CI = 13.8-16.6%; 0.9-1.7%; and 0.2-0.8%), respectively.
§ Considering total of both periods and excluding those who did not answer: Pearson's $\chi^2$, $p = 0.004$.
¦ Excluding those who did not answer: prevalence = 8.4; and 4.6% (95%CI = 7.5-9.5%; and 3.8-5.4%), respectively.
¶ Excluding those who did not answer: prevalence = 6.4; and 3.9% (95%CI = 5.5-7.4%; and 3.2-4.7%), respectively.
¶¶ Considering total of both periods and excluding those who did not answer: Pearson's $\chi^2$, $p = 0.177$.
** Excluding those who did not answer: prevalence = 4.8% (95%CI = 4.1-5.6%).
†† Excluding those who did not answer: prevalence = 4.1% (95%CI = 3.4-4.9%).
Source: ISAAC project.

reported asthma prevalence. Also in São Paulo, another survey found that the reported asthma prevalence among adolescents had not increased in a 3-year period.[27] The reduced prevalence in Recife could be attributed to the increase in the proportion of public schools where the poorest students are concentrated. These findings are in agreement with those of Chew et al.,[28] who related higher socioeconomic status with greater prevalence in Thai schoolchildren.

The increase in reported asthma prevalence found in other locations may be the result of an information bias. Doctors who are more alert to a particular problem tend to diagnose more cases.[29] One possible factor to be taken into account in Recife is underdiagnosis. In a survey of one English city the lower socioeconomic strata were observed to have a tendency towards underdiagnosis.[30]

With respect of prevalence differences between the sexes, the first survey found that the majority of asthmatics were male adolescents and in 2002 the preponderance was female. There is no obvious justification for these findings. International and national surveys conflict.[23,27,31]

With reference to the prevalence of dyspnea and wheezing having been twice that of reported asthma, one could reflect that, firstly, other conditions may be causing the symptom, such as recurrent viral or parasitic infections, eosinophilic syndromes, and others. Additionally, asthma may be underreported. Siersted et al.[32] observed underdiagnosis in 1/3 of cases among schoolchildren in Denmark, and in 2/3 of those who were not diagnosed, doctors were not informed of the symptoms.

Comparing annual wheezing (less subject do recall bias) and reported asthma, low sensitivity, low positive

**Table 4 -** Reported cumulative asthma prevalence, wheezing in the last 12 months and number of wheezing crises in the last 12 months in terms of maternal educational level of students aged 13 and 14 years-old (Recife, 1994-95 and 2002)

| | Period | | | | | |
|---|---|---|---|---|---|---|
| | 1994-95 | | | 2002 | | |
| | Asthma at any time in their life | | | Asthma at any time in their life | | |
| **Educational level** | **Present n* (%)** | **Absent n (%)** | **Prevalence (%)** | **Present n† (%)** | **Absent n (%)** | **Prevalence (%)** |
| Has never attended school | 31 (5.2) | 164 (7.5) | 15.9 | 33 (6.8) | 249 (11.6) | 11.7 |
| Incomplete elementary school | 92 (15.5) | 609 (27.9) | 13.1 | 133 (27.4) | 796 (37.2) | 14.3 |
| Elementary school | 66 (11.1) | 281 (12.9) | 19.0 | 45 (9.2) | 240 (11.2) | 15.2 |
| Incomplete high school | 28 (4.7) | 132 (6.1) | 21.2 | 31 (6.4) | 136 (6.4) | 18.6 |
| High school | 152 (25.5) | 406 (18.6) | 27.2 | 117 (24.1) | 419 (19.6) | 21.8 |
| College | 226 (38.0) | 588 (27.0) | 27.8 | 127 (26.1) | 299 (14.0) | 29.8 |
| Total | 595 (100) | 2,180 (100.0) | 21.4 | 486 (100) | 2,139 (100) | 18.5 |
| | **Wheezing in the last 12 months** | | | **Wheezing in the last 12 months** | | |
| **Educational level** | **Present n‡ (%)** | **Absent n (%)** | **Prevalence (%)** | **Present n§ (%)** | **Absent n (%)** | **Prevalence (%)** |
| Has never attended school | 32 (5.9) | 168 (7.5) | 16.0 | 42 (8.1) | 237 (11.2) | 15.0 |
| Incomplete elementary school | 116 (21.2) | 588 (26.2) | 16.5 | 182 (35.2) | 753 (35.7) | 19.5 |
| Elementary school | 67 (12.2) | 285 (12.7) | 19.0 | 49 (9.5) | 235 (11.1) | 17.2 |
| Incomplete high school | 26 (4.8) | 136 (6.0) | 16.0 | 30 (5.8) | 136 (6.5) | 18.1 |
| High school | 127 (23.2) | 432 (19.2) | 22.7 | 115 (22.2) | 424 (20.1) | 21.3 |
| College | 179 (32.7) | 638 (28.4) | 21.9 | 99 (19.2) | 324 (15.4) | 23.4 |
| Total | 547 (100) | 2,247 (100) | 19.6 | 517 (100) | 2,109 (100) | 19.7 |
| | **Number of crises in the last 12 months** | | | **Number of crises in the last 12 months** | | |
| **Educational level** | **Four or more n¦ (%)** | **Up to three n (%)** | **Prevalence of four or more (%)** | **Present n¶ (%)** | **Up to three n (%)** | **Prevalence of four or more (%)** |
| Has never attended school | 3 (3.0) | 30 (6.6) | 9.1 | 1 (2.2) | 33 (8.1) | 2.9 |
| Incomplete elementary school | 18 (18.2) | 98 (21.5) | 15.5 | 14 (30.4) | 137 (33.7) | 9.3 |
| Elementary school | 10 (10.1) | 61 (13.4) | 14.9 | 5 (10.9) | 38 (9.4) | 11.6 |
| Incomplete high school | 2 (2.0) | 24 (5.3) | 7.7 | 4 (8.7) | 25 (6.2) | 13.8 |
| High school | 30 (30.3) | 97 (21.3) | 23.6 | 7 (15.2) | 94 (23.1) | 6.9 |
| College | 36 (36.4) | 145 (31.9) | 19.9 | 15 (32.6) | 79 (19.5) | 16.0 |
| Total | 99 (100) | 455 (100) | 17.9 | 46 (100) | 406 (100) | 10.2 |

* Considering both groups: $\chi^2$ of trend, $p < 0.001$.
† Considering both groups: $\chi^2$ of trend, $p < 0.001$.
‡ Considering both groups: $\chi^2$ of trend, $p < 0.001$.
§ Considering both groups: $\chi^2$ of trend, $p = 0.010$.
¦ Considering both groups: $\chi^2$ of trend, $p = 0.045$.
¶ Considering both groups: $\chi^2$ of trend, $p = 0.128$.
Source: ISAAC project.

predictive value and low Youden index were observed. Specificity and negative predictive value were, however, elevated.[33] In general, the accuracy of a measure is tested against a gold standard. In the absence of such, clinical history is sufficient for an epidemiological diagnosis of asthma.[33] Nevertheless, this review only covered studies in the English, German, Danish and Italian languages. This being the case, their conclusions are not applicable to Portuguese-speaking countries. Using a subset of 209 schoolchildren subjected to pulmonary function tests, Camelo-Nunes et al.[27] also found a low level of accuracy for diagnosis by symptoms.

The increase in the prevalence of nocturnal cough in 2002 is in contrast with the reduction in reported asthma. It is possible that in Recife, where respiratory infections (which present with coughing) are common, this question has not been precise enough as the central committee for ISAAC itself points out.[23]

For epidemiological purposes, exercise challenge tests are questionable for the diagnosis of exercise-induced asthma.[35] Comparing the responses to the ISAAC questionnaires with bronchial hyperresponsivity from exercise, Ponsonby et al.[36] found that, in Tasmanian children, sensitivity and specificity were 60 and 77%,

**Table 5 -** Number of wheezing crises in the last 12 months affecting sleep and compromising speech in terms of the maternal educational level of students aged 13 and 14 years-old (Recife, 1994-95 and 2002)

| | Period | | | | | |
|---|---|---|---|---|---|---|
| | 1994-95 | | | 2002 | | |
| | Number of crises affecting sleep in the last 12 months | | | Number of crises affecting sleep in the last 12 months | | |
| **Educational level** | **Present n* (%)** | **Absent n (%)** | **Prevalence* (%)** | **Present n* (%)** | **Absent n (%)** | **Prevalence† (%)** |
| Has never attended school | 29 (8.2) | 170 (7.0) | 14.6 | 26 (9.4) | 255 (10.8) | 9.2 |
| Incomplete elementary school | 86 (24.5) | 616 (25.3) | 12.2 | 108 (38.8) | 830 (35.3) | 11.5 |
| Elementary school | 44 (12.5) | 308 (12.6) | 12.5 | 31 (11.2) | 253 (10.8) | 10.9 |
| Incomplete high school | 18 (5.1) | 144 (5.9) | 11.1 | 17 (6.1) | 149 (6.3) | 10.2 |
| High school | 80 (22.7) | 478 (19.6) | 14.3 | 54 (19.4) | 485 (20.6) | 10.0 |
| College | 95 (27.0) | 722 (29.6) | 11.6 | 42 (15.1) | 381 (16.2) | 9.9 |
| Total | 352 (100) | 2,438 (100) | 12.6 | 278 (100) | 2,353 (100) | 10.6 |
| | Number of crises compromising speech in the last 12 months | | | Number of crises compromising speech in the last 12 months | | |
| **Educational level** | **Present n* (%)** | **Absent n (%)** | **Prevalence‡ (%)** | **Present n* (%)** | **Absent n (%)** | **Prevalence§ (%)** |
| Has never attended school | 12 (9.4) | 188 (7.1) | 6.0 | 11 (10.2) | 271 (10.7) | 3.9 |
| Incomplete elementary school | 36 (28.1) | 668 (25.1) | 5.1 | 46 (42.6) | 890 (35.2) | 4.9 |
| Elementary school | 19 (14.8) | 333 (12.5) | 5.4 | 13 (12.0) | 273 (10.8) | 4.5 |
| Incomplete high school | 4 (3.1) | 158 (5.9) | 2.5 | 9 (8.3) | 157 (6.2) | 5.4 |
| High school | 29 (22.7) | 529 (19.8) | 5.2 | 17 (15.8) | 524 (20.7) | 3.1 |
| College | 28 (21.9) | 789 (29.6) | 3.4 | 12 (11.1) | 413 (16.4) | 2.8 |
| Total | 128 (100) | 2,665 (100) | 4.6 | 108 (100) | 2,528 (100) | 4.1 |

* Considering both groups: $\chi^2$ of trend, p = 0.711.
† Considering both groups: $\chi^2$ of trend, p = 0.555.
‡ Considering both groups: $\chi^2$ of trend, p = 0.080.
§ Considering both groups: $\chi^2$ of trend, p = 0.078.
Source: ISAAC project.

**Table 6 -** Wheezing prevalence in the last 12 months according to the reported cumulative asthma prevalence with the respective diagnostic tests of students aged 13 and 14 years-old (Recife, 1994-95 and 2002)

| | Period | | | |
|---|---|---|---|---|
| | 1994-95 | | 2002 | |
| | Asthma at any time in their life* | | Asthma at any time in their life† | |
| **Wheezing in the last 12 months** | **Present n* (%)** | **Absent n (%)** | **Present n† (%)** | **Absent n (%)** |
| Present | 333 (51.8) | 270 (11.2) | 226 (46.0) | 292 (13.2) |
| Absent | 310 (48.2) | 2,149 (88.8) | 265 (54.0) | 1,927 (86.8) |
| Total | 643 (100) | 2,419 (100) | 491 (100.0) | 2,219 (100.0) |

* Pearson's $\chi^2$, p < 0.001.
† Pearson's $\chi^2$, p < 0.001. Sensitivity % (95%CI): 1994-95 = 51.8 (47.9-55.6); 2002 = 46 (41.6-50.4). Especificity % (95%CI): 1994-95 = 88.8 (87.6-90.1); 2002 = 86.8 (85.4-88.2). Positive predictive value % (95%CI): 1994-95 = 55.2 (51.2-59.2); 2002 = 43.6 (39.4-47.9). Negative predictive value % (95%CI): 1994-95 = 87.4 (86.1-88.7); 2002 = 87.9 (85.5-89.3). Absolute Youden index (limits): 1994-95 = 0.41 (0.37-0.45); 2002 = 0.33 (0.28-0.37).
Source: ISAAC project.

respectively, and concluded that the questionnaire was accurate. In the current study this variable also altered differently from reported asthma.

Frequent and severe crises indicate the need for long term pharmacotherapy.[1-4] Both the number of students suffering frequent wheezing episodes (four crises or more) and episodes disturbing sleep reduced in proportion with reported asthma. The prevalence of crises that interfered with speech, however, did not change over time. It is possible that the severity of the disease has altered, with severe crises (affecting speech) having grown in proportion. The study design, however, does not allow this question to be studied in depth.

In contrast to the reported asthma prevalence, maternal education was not related to asthma severity, as has been observed by several authors.[10,28,37-40] There is no explanation for the finding. According to Rona,[18] poverty is not a risk factor for the appearance of asthma, but an aggravating factor. With respect of what has been observed in Recife, it is possible that asthma really is more prevalent among children and adolescents from families in better socioeconomic conditions, as was observed by Chew et al.[28] Another aspect to be taken into consideration is underdiagnosis being more common among individuals in worse socioeconomic conditions.[30] A third factor could be the presence of other determinants other than atopic disease in poor communities. Faniran et al.[41] studied children from 8 to 11 years old in Ojo (Nigeria) and in Sidney (Australia) and found that wheezing and coughing were more prevalent in Nigeria, but that there were no significant differences in terms of atopic disease. The findings obtained in Recife are in agreement with the hygiene theory.[1] That is, adolescents of a lower socio-economic level would have had, at an early age, more contact with infectious agents, making them less susceptible to atopic disease. One could also, however, make the interpretation that asthmatics miss school more often, as observed in the United States in 1994-95,[42] and this absenteeism would be more common among the poor, the results therefore reflecting less asthmatics than expected. The complexity of defining socioeconomic status should also be taken into account, and maternal schooling, while being associated with the nutritional status of children from the Northeast of Brazil,[43,44] may not be sufficiently accurate when used as a single indicator.

Further limitations: in Brazil a significant proportion of children do not attend school. The sample is not, therefore, representative of the city's children. Furthermore, video-questionnaires were not used in the surveys in Recife, which could possibly have improved the quality of the responses.

Summing up, this study offers new and relevant insights into the high prevalence of asthma in our region, alerting health planners to prioritize resources for its control and clinicians to be more aware of the problem.

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