Risk factors for asthma and allergic diseases in school children across Lebanon

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Introduction: Childhood asthma is one of the most important diseases of childhood.1 Despite a decrease of mortality around the world, it is still taxed by high morbidity.2 The natural history of asthma is still largely unknown3 and risk factors for asthma and other allergic diseases such as rhinitis and eczema are currently studied and discussed,4–6 but remain controversial on many issues.3,7 Although genetic predisposition and environmental exposure are thought to lead to the development of these conditions, the nature of such associations remains unclear.7,8

We have recently conducted an epidemiological study in Lebanon, with the objective of determining prevalence and risk factors of allergic diseases in Lebanese schoolchildren. Prevalence data have been reported previously: allergic diseases were found to be on the medium prevalence trend noted all over the world.9,10 The present analysis was performed to determine which factors were independently associated with asthma, allergic rhinitis, atopic eczema, or any combination of these.

Material and methods
Study design
Our study is an analytical cross-sectional study carried out on school children in Lebanon.

The dependent variables were physician-diagnosed asthma, assessed by the answer to the question: “Has your doctor ever said you had asthma?” Asthma symptoms such
as wheezing ever, last 12 months wheezing, and wheezing on exercise without physician diagnosis, according to the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire were also evaluated. A probable asthma was defined as physician diagnosed asthma or having suffered from any asthma symptoms (wheezing ever, 12 months wheezing, or wheezing on exercise).

Allergic rhinitis was also assessed by the question: “Have you ever had a problem with sneezing, or a runny or blocked nose when you did not have cold?” In addition, atopic eczema was considered positive if the individual answered yes to one of the following questions: “Have you ever had eczema?” Or “Have you ever had an itchy rash on the folds of the elbows, behind the knees, in front of the ankles, under the buttocks, or around the neck, ears or eyes?”

Any allergic disease was defined as having probable asthma, allergic rhinitis, or atopic eczema.

Independent variables were age, school type, sex, parental education, and potential risk factors of asthma and allergic diseases, such as parental smoking, parental respiratory problem, infancy gastro esophageal reflux, recurrent otitis, bedroom carpet presence, humidity in bedroom, animal possession, type of mattress and pillow, and heating manner, etc.

**Methods**

The sampling unit was a school. Thirty schools were randomly selected from a list of schools provided by the Ministry of Education: 13 public and 17 private schools. Eight schools (1 public and 7 private) refused to participate, while 22 out of 30 (73.3%) agreed to distribute the questionnaires to their students between first and ninth grades. Standardized questionnaires were distributed to children aged 5 to 12 years and they had to take the questionnaire home to be completed by their parents and returned to school to be picked up by the inquirer, while others were distributed to children aged 13 to 14 years who would complete the questionnaire at school, supervised by the inquirer.

The standardized ISAAC written core questionnaire was used, after translation into Arabic and translation back into English to ensure questions accuracy. Additional details about the study methodology exist in specific publications.

**Statistical analysis**

Questionnaires were coded and data introduced on Statistical Package for Social Sciences (SPSS) software (version 12.0; SPSS Inc., Chicago, IL, USA) by independent lay persons. Data entry was then controlled twice, and data analysis was performed by the same SPSS software. Weighting cases was performed according to population distribution by age group, sex and governate in Lebanon by Central Administration of Statistics. Cluster effect was taken into account according to the method suggested by Rumeau-Rouquette and collaborators.

A p-value < 0.05 was considered significant. The Chi-square test was used for comparison between categorical variables, while Student test was used for comparison of means between groups. For multivariate analysis, step-wise backward likelihood ratio logistic regressions were performed for diseases, taking into account the studied sociodemographic and factors that presented a significant or a borderline (p < 0.20) association in bivariate analysis. Adjusted odds ratios (OR) were then calculated.

**Results**

In Table 1, questionnaires distribution across Lebanese governate is presented. 7679 questionnaires were distributed, and overall response rate was 72%. After weighting on distribution by age group, sex, and governate in Lebanon, analysis was finally done on 5544 questionnaires (Table 1).

Public schools (OR = 1.67; p < 10⁻⁴), higher age categories (p < 10⁻⁴), male sex (OR = 1.36; p < 10⁻⁴), and father and mother lower education (p < 10⁻⁴) are associated with higher odds of probable asthma, defined as physician diagnosed asthma or asthma symptoms (all wheezing) (Table 2). A smoking mother (OR = 1.43), a smoking father (OR = 1.30), a father (OR = 2.33), or mother lung problem (OR = 2.22), infancy gastroesophageal reflux (OR = 2.13), recurrent otitis (OR = 2.38), heart problem (OR = 4.60), previous pertussis (OR = 3.39), humidity on bedroom walls (OR = 1.79), and animal possession (OR = 1.57) were all significantly associated with probable asthma (Table 3).

On the other hand, age and infant day care attendance (OR = 1.23) were also found to be associated with allergic rhinitis (Table 2). A father (OR = 2.33), or mother lung problem (OR = 2.22), a smoking father (OR = 1.32) or mother (OR = 1.20), infancy gastroesophageal reflux disease (OR = 2.11), recurrent otitis (OR = 2.27), previous pertussis (OR = 1.23), humidity on bedroom walls (OR = 1.56), and a spongy pillow (OR = 1.39) were also significantly associated with allergic rhinitis (Table 3).

For atopic eczema, no association was found for any socioeconomic factor, except for a protective effect for the child when sleeping in his own bed (OR = 0.73; p = 0.001) (Table 2). However a father (OR = 1.72), or mother (OR = 2.27) lung problem, recurrent otitis (OR = 2.17),
previous pertussis (OR = 1.28), a spongy pillow (OR = 1.61), an artificial (OR = 1.25) mattress were significantly associated with atopic eczema (Table 3).

When these allergic diseases were combined together, risk factors identified as significantly associated with their occurrence were nearly identical to those of individual diseases (Tables 2 and 3).

All the results of bivariate analysis were confirmed by multivariate analysis in the majority of cases, while some risk factors lost the significant association found in bivariate analysis (Table 4).

**Discussion**

This is a cross sectional study carried on schoolchildren in Lebanon, addressing potential risk factors for asthma, rhinitis and eczema. Male sex was found a significant risk factor for asthma. It has been shown previously in the literature that male sex is predominant in asthma population in the first decade.15 Indeed our sample included school children from 5–14-years-old and few of them were in the category of 13–14-years-old. On the other hand, older age was also found a risk factor for asthma in our study. This seems logical considering the cumulative years’ effect in asthma which is a chronic disease.3 Again, being in public schools was retained in our model as a risk factor for asthma, and children going to public schools were found – in previous personal publications16 – less controlled for their disease. According to data in the literature where a less favorable environment per se is observed as impacting asthma; 17 we might argue that being in public schools in Lebanon may reflect indirectly a low socioeconomic status.

Familial history for lung diseases in the mother and the father is also a risk factor for asthma retained in our model. This has been shown in previous studies specifically for familial history of atopy.3,8 On the other hand, the effect of smoking parents on children has been shown to be a triggering factor to express asthma in children even in early life.5,18,19 In our models, both the smoking mother and father were shown to be risk factor for asthma and allergic diseases. The parents’ education was not shown to be risk factor for asthma and allergic diseases in multivariate analysis, although we found in previous analyses that the low mother education was correlated to a worse control of asthma.16 Environmental factors found associated with asthma in our population were the presence of molds on bedrooms’ walls and pets’ possession. This is also in concordance with other studies.3,7,20 Although dust mites are known indoor environmental factor for asthma,3,7,20 they were not found in our study as so. Indeed, the floor coverage with carpets in the bedroom or the use of feather pillows7,20,21 reflects indirectly the hypothetical presence or absence of dust mites. In our questionnaires, the questions addressing the house environment were subdivided into numerous items that might not precisely reflect the dust mites’ presence. Another possible reason is that our study is an epidemiologic one, and was not designed to document atopy by skin prick tests as per example.

Recurrent otitis is a risk factor for asthma and allergic diseases in our study. The known risk factors for recurrent ear infections include atopy, male gender, and day care attendance,22 while few studies have showed a positive strong association between asthma and recurrent ear infections per se among children.23 This relationship needs further prospective studies to be closely depicted. In addition, heart problems were found correlated to higher risk of asthma in this study. Interestingly a recent prospective study by Massin and collaborators24 showed that a substantial proportion of children with congenital heart disease have significant non cardiac co morbidities, among which asthma was found the most frequent. Moreover, pertussis infection is found to be a

**Table 1** Questionnaires distribution by governate

| Governate       | Total distributed | Total questionnaires | Weight | Weighted numbers and percentages |
|-----------------|-------------------|----------------------|--------|----------------------------------|
| Bekaa           | 1370              | 784 (14.2%)          | 0.89   | 698 (12.6%)                      |
| Beirut          | 388               | 324 (5.9%)           | 1.76   | 570 (10.3%)                      |
| Mount Lebanon   | 2572              | 2225 (40.3%)         | 0.99   | 2203 (39.7%)                     |
| El Nabatieh     | 935               | 653 (11.8%)          | 0.50   | 327 (5.9%)                       |
| North Lebanon   | 1831              | 1244 (22.5%)         | 0.91   | 1157 (20.9%)                     |
| South Lebanon   | 583               | 292 (5.3%)           | 2.02   | 590 (10.6%)                      |
| Total           | 7679              | 5522 (100%)          | 5544   | (100%)                           |

Notes: *Response rate was 71.9%; *Weighting was performed according to population distribution by age group, sex, and governate in Lebanon by Central Administration of Statistics.13
risk factor for asthma in our study. This has been a debatable issue and controversial matter. This controversy is related mainly to the “hygiene hypothesis”25,26 where is debated the protective21 or nonprotective effect20 of early endotoxin exposure—whether environmental or infectious—on developing atopic diseases. Some experimental studies and epidemiologic ones seem to confirm the nonprotective effect of previous Bordetella pertussis infection on bronchial hyperreactivity.27,28

Infant gastroesophageal reflux was also found a risk factor in our population. It has been reported that gastroesophageal reflux disease (GERD) occurs in about two thirds of children with asthma.29,30 It may simply represent a concomitant unrelated finding or it may be responsible for provoking or worsening asthma.30 GERD could also be a byproduct of asthma itself. In any case, aggressive treatment of GERD seems to improve asthma outcomes. GERD should be suspected in asthma patients who do not have any known risk factors or those who are becoming difficult to treat.29

As for asthma, some of the risk factors were found for allergic rhinitis too, in accordance with other studies: age,3,4 a parental lung problem,3–5 infant gastroesophageal reflux disease,29 recurrent otitis;22 previous pertussis,27,28 humidity on bedroom walls.3–5 This is definitely a reflection of the same airway disease concept.4,8 A smoking father was found as a risk factor for rhinitis in our population. This is

### Table 2 Socioeconomic factors associated with allergic diseases

| Disease status | Total exposure N = 5544 (100%) | Probable asthma\(^a\) N = 1082 (19.5%) | Allergic rhinitis N = 1360 (24.5%) | Atopic eczema N = 641 (11.6%) | Any allergic disease N = 2196 (39.6%) |
|---------------|---------------------------------|----------------------------------------|---------------------------------|--------------------------------|-----------------------------------|
| **Socioeconomic factors** |                                 |                                        |                                 |                               |                                   |
| Public school vs private school |                                |                                        |                                 |                               |                                   |
| [5–8] years | 1585 (28.6%) | 1.00; <10\(^{-4}\) | 1.00; <10\(^{-4}\) | 1.00; 0.98 | 1.00; <10\(^{-4}\) |
| [8–10] years | 1202 (21.7%) | 1.03 [0.84–1.26] | 1.15 [0.96–1.39] | 1.03 [0.82–1.31] | 1.07 [0.91–1.25] |
| [10–13] years | 1796 (32.4%) | 1.48 [1.25–1.78] | 1.37 [1.16–1.61] | 1.00 [0.81–1.24] | 1.36 [1.18–1.56] |
| >13 years | 960 (17.3%) | 2.06 [1.70–2.51] | 2.22 [1.85–2.66] | 0.98 [0.76–1.26] | 2.00 [1.70–2.36] |
| Male sex | 2890 (52.2%) | <10\(^{-4}\); 1.39 | 0.37; 1.05 | 0.44; 1.06 | 0.001; 1.19 |
| **Father education** |                                 |                                        |                                 |                               |                                   |
| Low | 1259 (23.4%) | 1.43 [1.19–1.72] | 1.15 [0.97–1.37] | 1.15 [0.91–1.45] | 1.28 [1.10–1.49] |
| Intermediate | 2518 (46.7%) | 1.09 [0.92–1.28] | 1.04 [0.91–1.22] | 1.02 [0.83–1.25] | 1.08 [0.95–1.22] |
| High | 1613 (29.9%) | 1.00; <10\(^{-4}\) | 1.00; 0.17 | 1.00; 0.44 | 1.00; 0.004 |
| **Mother education** |                                 |                                        |                                 |                               |                                   |
| Low | 963 (17.8%) | 1.39 [1.15–1.67] | 1.14 [0.94–1.37] | 1.09 [0.85–1.39] | 1.21 [1.04–1.42] |
| Intermediate | 2659 (49.3%) | 1.02 [0.87–1.20] | 1.03 [0.91–1.19] | 0.88 [0.73–1.08] | 1.02 [0.96; 1.06] |
| High | 1775 (32.9%) | 1.00; <10\(^{-4}\) | 1.00; 0.39 | 1.00; 0.17 | 1.00; 0.038 |
| Child sleeps in his own bed | 4824 (87.9%) | 0.93 [0.74–1.13] | 0.97 [0.74–1.13] | 0.82 [0.68–1.01] | 0.84 [0.64–1.12] |
| **Infancy daycare** | 130 (23.8%) | 0.32 [0.23–1.23] | 0.32 [0.23–1.23] | 0.32 [0.23–1.23] | 0.32 [0.23–1.23] |
| **Electrical vacuum** | 4917 (89.4%) | 0.39 [0.39–1.91] | 0.40 [0.39–1.91] | 0.40 [0.39–1.91] | 0.40 [0.39–1.91] |
| Persons per chamber |                                 |                                        |                                 |                               |                                   |
| >1.6 | 1826 (32.9%) | 0.99 [0.83–1.19] | 1.12 [0.95–1.33] | 0.90 [0.72–1.13] | 1.08 [0.93–1.25] |
| 1–1.6 | 2493 (45.0%) | 1.03 [0.87–1.22] | 1.12 [0.96–1.32] | 1.11 [0.90–1.38] | 1.12 [0.98–1.30] |
| <1 | 1225 (22.1%) | 0.92; 1.00 | 0.17; 1.00 | 0.37; 1.00 | 0.30; 1.00 |

**Note:** \(^a\)Probable asthma includes asthma-like symptoms with or without physician diagnosis.
consistent with results of the literature where environmental tobacco smoke was found a risk factor for rhinitis. On the other hand, the use of a spongy pillow was also significantly associated with an increased risk of allergic rhinitis in our population which also is consistent with literature findings. Interestingly enough, infant day care attendance was found associated with allergic rhinitis in our study. In previous studies, no sign of protection from day care attendance for allergic diseases was found up to 6 years of age, and multiple airway infections and day care attendance were found to be independently associated with asthma and allergic symptoms.

For atopic eczema, no association was found for any socioeconomic factor in our population, except for the child sleeping in his own bed. However a father or mother lung problem, the use of a spongy pillow, wool or an artificial mattress were shown significantly associated with atopic eczema, both in the literature and in our study. Infant GERD, recurrent otitis, previous pertussis were also risk factors for eczema in our population. This may be explained by what has been reported in the literature, where eczema, asthma and allergic rhinitis are parts of the same atopic disease.

We are aware of the possible biases introduced by this study design. A selection bias is possible because of the refusal of the 8 schools to participate to the study, 7 of them being private. We would expect this to have caused the underestimation of diagnosed asthma but the overestimation of undiagnosed diseases and symptoms in our study. An information bias is also possible since the use of a questionnaire in a young population or for surrogate responders (parents) may not always be accurate: problems in question understanding, recall deficiency and over or under evaluating symptoms may still be possible.
The same applies for different potential risk factors. In addition, some questions may refer to potential risk factors that do not necessarily precede the disease, suggestive of the temporality problem found in cross-sectional designs. However, our methodology is that of other cross-sectional studies, including ISAAC ones, which is necessary for international comparisons. As for causality assessment between potential risk factors and allergic diseases, it is beyond the scope of our work. Nevertheless, several previous reviews have carefully evaluated the matter and proved causality with more or less strong evidence between much of the associated factors we found and allergic diseases.\(^7,32\)

**Conclusion**

Asthma, allergic rhinitis and eczema seem to be similarly affected by several risk factors in our population of Lebanese school children across Lebanon. The majority of these factors are preventable, thus permitting a possible reduction of the prevalence of these allergic diseases.

**Disclosure**

The authors report no conflicts of interest in this work.

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