Atopic profile of asthmatic children in Bahrain

K.S. Tabbara,1 A. Ibrahim,2,3 R. Ajjawi3 and F. Saleh1,4

ABSTRACT This study aimed to define the profile of asthmatic children in Bahrain and the prevalence of sensitization to aeroallergens and foods. A total of 95 children who were clinically diagnosed with asthma were enrolled: 71.6% mild, 20.0% moderate and 8.4% severe asthma (NIH criteria). Serum IgE concentrations were elevated (> 200 kU/L) in 21.1% of patients and highly elevated (> 400 kU/L) in 9.5%. Absolute eosinophil counts were elevated (> 350 × 106/L) in 54.8%. Overall, 67.4% of children were atopic; 56.8% were sensitive to inhalant allergens and 39.0% to foods. The atopic profile was generally similar to asthmatic children in the region and worldwide. Conditions significantly associated with atopic asthma included food allergies, allergic rhinitis and eczema.

Profil atopique des enfants asthmatiques à Bahreïn

RÉSUMÉ La présente étude avait pour objectif de définir le profil des enfants asthmatiques à Bahreïn et la prévalence de la sensibilisation aux aéroallergènes et à certains aliments. Au total, 95 enfants ayant fait l’objet d’un diagnostic clinique d’asthme ont été inclus dans l’étude. Selon les critères du National Institute of Health, 71.6 % d’entre eux souffraient d’asthme léger, 20.0 % d’asthme modéré et 8.4 % d’asthme sévère. Les concentrations sériques d’IgE étaient élevées (> 200 kU/L) chez 21.1 % des patients et très élevées (> 400 kU/L) chez 9.5 % des enfants. Le nombre absolu d’éosinophiles était élevé (> 350 × 106/L) chez 54.8 % des patients de l’étude. Globalement, 67.4 % des enfants étaient atopiques ; 56.8 % présentaient une sensibilité aux allergènes inhalés et 39.0 % à certains aliments. Le profil atopique des enfants asthmatiques dans la région était généralement similaire au profil des enfants des autres pays dans le monde. Les affections fortement associées à un asthme atopique étaient les allergies alimentaires, la rhinite allergique et l’eczéma.
Introduction

Bronchial asthma is one of the commonest multifaceted chronic diseases. The worldwide incidence of asthma has been increasing in frequency and severity in recent years, particularly among children and young adults [1], and it has become a leading cause of emergency department admissions and school absenteeism in children. Atopy is the major predisposing factor for asthma in children. It seems likely that atopy results from a deviation of the immune response towards the activation of T-helper type 2 lymphocytes, resulting in a chronic inflammatory response associated with the induction of IgE class antibodies and eosinophilia [2].

The main route of allergen exposure in asthma is by inhalation. Common aeroallergens reflect both the indoor as well as the outdoor flora and fauna of a country. Substances that are generally recognized as important inhalant allergens include pollens, mould spores, house dust mites and insect and animal proteins [3–5]. Food allergy, which has been shown to account for 2% to 8.5% of the underlying allergies in asthmatic children [6], is frequently overlooked in asthma. The prevalence of food allergies seems to have increased in the last decade and an accurate history is important in identifying food allergies in patients. Diagnostic tests for food allergies include skin testing and food-specific IgE assay, while oral challenge may be indicated in certain situations. Symptoms of food allergies vary from atopic dermatitis or gastrointestinal symptoms to violent anaphylaxis [7].

Foods that are often implicated in food allergies include egg, milk, nuts, wheat, soya and fish. Sensitization to these is usually acquired in childhood [8].

The desert nature of the Gulf region, coupled with the hot, humid weather predisposes the population to indoor living in an air-conditioned environment for a major part of the year. Reported prevalence rates of asthma in the Gulf Cooperative Council (GCC) population range between 8% and 23% [9–12], higher than rates reported in the USA [1] or Europe [13]. Despite the desert environment, pollen is reported to constitute a major sensitizing allergen in several GCC countries [14,15], followed by indoor allergens, including house dust, animal dander and moulds [15–18].

There are no published studies defining the profile of asthmatic children in Bahrain and the contribution of aeroallergens and food allergy to the development of this condition in the residents of Bahrain. This study explored the demographical profile and the environmental living conditions of a sample of asthmatic children in Bahrain, including the prevalence of atopic asthma and its association with other atopic diseases in these patients.

Methods

Sample

All 95 consecutive children referred to the Salmaniya Medical Complex (the principal government hospital in Bahrain with a capacity of 1300 beds) between January and December 2000 who were clinically diagnosed with asthma were enrolled in the study. Ethical approval for the study was obtained from the research committees of both the Arabian Gulf University and Salmaniya Medical Complex. Oral consent was obtained from the parents of children participating in the study.

Data collection

Demographic, clinical, allergic and therapeutic histories were collected from the records and the parents of all participants and a questionnaire checklist was filled by the interviewer.

Two 5 mL samples of blood were collected from each patient by venepuncture. Total white blood cell count was carried out using a Coulter counter (Beckman Coulter). A differential count was carried out using routine procedures and absolute eosinophil counts were calculated. The cutoff for elevated eosinophils was > 350 x 10^6/L.

Serum was separated and frozen at –80 °C until assayed for total and allergen-specific IgE. Total serum IgE concentrations were determined by sandwich enzyme-linked immunoassay (ELISA) using a commercial kit (Bethyl Laboratories). Allergen-specific IgE assays were determined on the Pharmacia UniCap system (Pharmacia Diagnostics), a fully integrated and automated ELISA system for measurement of total and allergen-specific IgE. The cutoff for elevated IgE was > 200 kU/L.

The determination of sensitivity to inhaled allergens was carried out by in vitro quantitative inhalant allergen-specific IgE test using Phadiatop® (ImmunoCAP), a balanced mixture of common allergens, while sensitivity to food allergens was carried out by a quantitative food allergen-specific IgE using f5® (ImmunoCAP), a food allergen mixture which includes egg white, milk, fish, wheat, peanut and soy bean. The manufacturer’s recommended cutoffs were used.

Asthma was defined according to National Institutes of Health (NIH) guidelines as mild (intermittent or persistent) asthma, moderate or severe [19]. Atopy was defined as positivity to either aero- or food allergens or both.

Analysis

Data compilation, tabulation, and statistical analysis were performed using Windows Excel and SPSS, version 14. The mean values of atopy-positive and atopy-negative patients were compared (atopy being defined as positivity to either Phadiatop or f5® or both) and significance was calculated using the Student t-test. Mean values of IgE/eosinophil counts for the various clinical groups were compared by ANOVA. Other variable were analysed using the chi-squared test. A P value of < 0.05 was considered significant.
Results

Background characteristics

The 95 children included in this study had been clinically diagnosed with recurrent asthma. At the visit when blood was collected for this study 88% were seen at the pulmonary outpatient paediatric clinic, 9% were admitted for exacerbated asthma and 3% were seen at the accident and emergency department.

The study group included 61 boys and 34 girls (ratio of 1.8:1) with a mean age of 6.8 (SD 3.8) years, range 6 months to 18 years. Most of the patients (82.1%) were Bahraini nationals and the majority were from low-income families (Table 1).

Asthma profile

Among the children 41.0% developed their first episode of asthma within the first 1 year of life, 58% within the first 2 years and 86% within the first 5 years. The majority of cases (71.6%) were classified as mild (intermittent or persistent) asthma, while 20.0% were moderate and 8.4% severe (Table 2). Asthma severity increased significantly with age ($P=0.001$); the mean age of children with mild intermittent asthma was 4.78 (SD 2.97) years, moderate asthma was 8.63 (SD 4.63) years and severe asthma was 9.25 (SD 3.73) years. There were no differences between Bahrainis and non-Bahrainis with respect to severity or prevalence of atopy (data not shown) ($P=0.751$ and $P=0.46$ respectively).

Atopic profile

Of the 95 asthmatic children studied, 56.8% were sensitized to aeroallergens and 39.0% to food allergens; 28.4% were sensitive only to aeroallergens and 10.6% only to foods but not aeroallergens. The overall rate of atopy (sensitization to aeroallergens or foods or both) in our sample was 67.4%. The rate of atopy appeared to be higher in girls (76.4%) than boys (62.2%), but this was not statistically significant ($P=0.771$), while the rate of food allergy was similar in both boys and girls (39.3% versus 38.2%) (Table 3).

Risk factors for atopy

We investigated various risk factors that are associated with atopy: 22.1% of asthmatic children were the product of consanguineous marriages and 81.1% had a family history of atopy (Table 4). Around half of the study children (51.6%) were exposed to animals at home, the majority (92.6%) lived in carpeted homes and one-third (31.6%) had a parent who smoked.

Almost one-third (31.6%) had at least 1 other associated atopic disease (eczema, allergic rhinitis, allergic conjunctivitis) and 25.3% reported a history of known food allergies. (Table 4) Allergic rhinitis was the most prevalent atopy (24.2%), followed by eczema (15.8%), while allergic conjunctivitis (4.2%) was the least prevalent among our sample.

Allergic rhinitis was significantly associated with laboratory-confirmed sensitivity to aeroallergens ($P=0.004$), while eczema was significantly associated with both sensitivity to aeroallergens ($P=0.048$) and to foods ($P=0.018$). The only risk factors investigated that were significantly correlated with atopy (sensitivity to either food or aeroallergens or both) were history of known food allergies and allergic rhinitis ($P=0.015$ and 0.021 respectively) (Table 4).

Table 1 Demographic data of asthmatic children

<table>
<thead>
<tr>
<th>Variable</th>
<th>Boys No. (%)</th>
<th>Girls No. (%)</th>
<th>Total No. (%)</th>
<th>Mean (SD) age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>61 (64.2)</td>
<td>34 (35.8)</td>
<td>95 (100.0)</td>
<td></td>
</tr>
<tr>
<td>Nationality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahraini</td>
<td>49 (51.6)</td>
<td>29 (30.5)</td>
<td>78 (82.1)</td>
<td></td>
</tr>
<tr>
<td>Non-Bahraini</td>
<td>12 (12.6)</td>
<td>5 (5.3)</td>
<td>17 (17.9)</td>
<td></td>
</tr>
<tr>
<td>Household income (US$/year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 10 000</td>
<td>–</td>
<td>–</td>
<td>45 (47.4)</td>
<td></td>
</tr>
<tr>
<td>10–20 000</td>
<td>–</td>
<td>–</td>
<td>28 (29.5)</td>
<td></td>
</tr>
<tr>
<td>&gt; 20 000</td>
<td>–</td>
<td>–</td>
<td>16 (16.8)</td>
<td></td>
</tr>
<tr>
<td>Mean (SD) age (years)</td>
<td>6.6 (3.8)</td>
<td>7.0 (3.9)</td>
<td>6.8 (3.8)</td>
<td></td>
</tr>
</tbody>
</table>

*No income data available for 6 families. SD = standard deviation.

Table 2 Clinical classification of asthmatic children in Bahrain

<table>
<thead>
<tr>
<th>Severity of attacks*</th>
<th>Boys (n = 61)</th>
<th>Girls (n = 34)</th>
<th>Total (n = 95)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Mild intermittent</td>
<td>24 (39.3)</td>
<td>7 (20.6)</td>
<td>31 (32.6)</td>
</tr>
<tr>
<td>Mild persistent</td>
<td>21 (34.4)</td>
<td>16 (47.0)</td>
<td>37 (38.9)</td>
</tr>
<tr>
<td>Moderate</td>
<td>10 (16.4)</td>
<td>9 (26.5)</td>
<td>19 (20.0)</td>
</tr>
<tr>
<td>Severe</td>
<td>6 (9.8)</td>
<td>2 (5.9)</td>
<td>8 (8.4)</td>
</tr>
</tbody>
</table>

*National Institutes of Health criteria [19]. SD = standard deviation.
Laboratory data

Serum IgE concentrations were elevated (> 200 kU/L) in 21.1% of patients and highly elevated (> 400 kU/L) in 9.5%, with an overall mean of 113 (standard deviation (SD 171) kU/L (range 0–1000 kU/L) (Figure 1A). Absolute eosinophil counts were elevated (> 350 x 10⁶/L) in 54.8% of patients, with a mean absolute level of 432 (SD 364) x 10⁶/L (range 0–1600 x 10⁶/L) (Figure 1B).

There was a significant difference between the means of atopy-positivity and atopy-negative patients for both total serum IgE concentration and absolute eosinophil count (P < 0.001 and P = 0.037 respectively). When analysed separately (sensitization to aeroallergens or to food allergens), the difference in means was significant for those who were sensitive to aeroallergens (P < 0.001 and P = 0.002 respectively) but not to food allergens (P = 0.07 and P = 0.302 respectively). There was no significant relationship between clinical severity of asthma and IgE concentration or absolute eosinophil count (P = 0.966 and 0.793, respectively).

Discussion

This study was undertaken to define the profile of asthmatic children in Bahrain with respect to clinical presentation and allergen laboratory parameters and to determine the frequency of atopic asthma among our sample.

Our sample included a predominance of boys compared to girls (ratio of 1.8:1), a finding that agrees with international [20,21], as well as regional reports [22–24]. The age of onset of asthma in our patients was consistent with those reported from the region [22], but earlier than those reported in industrialized counties, as 58% of our patients, as compared to one-third in Sweden [25], developed their first episode within their first 2 years of life. Extended enclosed living in air-conditioned buildings, living in carpeted homes (92.6% of our patients) and contact with animals at home (51.6% of patients) might be contributing factors.

Severity of asthma in our patients followed worldwide trends [26,27], with an increasing rate of severity with age (P < 0.001), although the percentage of affected children in each age group decreased, and there were no significant differences between boys and girls or Bahrainis and non-Bahrainis, suggesting a greater role for environmental than genetic factors.

Table 3 Distribution of sensitization to aeroallergens and foods among asthmatic children

<table>
<thead>
<tr>
<th>Sensitivity to:</th>
<th>Boys (n = 61)</th>
<th>Girls (n = 34)</th>
<th>Total (n = 95)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aero-allergens</td>
<td>Food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>–</td>
<td>–</td>
<td>23</td>
<td>37.7</td>
</tr>
<tr>
<td>+</td>
<td>–</td>
<td>14</td>
<td>22.9</td>
</tr>
<tr>
<td>–</td>
<td>+</td>
<td>4</td>
<td>6.5</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>20</td>
<td>32.8</td>
</tr>
</tbody>
</table>

*Phadiatop® positive; fx5® positive.

Table 4 Risk factors for atopy and the significance of their correlation with various sensitization groups for asthmatic children in Bahrain

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Total (n = 95)</th>
<th>%</th>
<th>Aero-allergens (n = 54)</th>
<th>Correlation (P-values) with sensitivity to: Foods (n = 37)</th>
<th>Either Aero-allergens or foods (n = 64)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consanguinous marriage</td>
<td>21</td>
<td>22.1</td>
<td>0.975</td>
<td>0.166</td>
<td>0.653</td>
</tr>
<tr>
<td>Carpeted home</td>
<td>88</td>
<td>92.6</td>
<td>0.60</td>
<td>0.02</td>
<td>0.38</td>
</tr>
<tr>
<td>Exposure to animals at home</td>
<td>49</td>
<td>51.6</td>
<td>0.899</td>
<td>0.398</td>
<td>0.694</td>
</tr>
<tr>
<td>Smoker in house</td>
<td>30</td>
<td>31.6</td>
<td>0.169</td>
<td>0.78</td>
<td>0.674</td>
</tr>
<tr>
<td>Family history of atopy</td>
<td>77</td>
<td>81.1</td>
<td>0.685</td>
<td>0.473</td>
<td>0.062</td>
</tr>
<tr>
<td>Other atopic conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Known food allergies</td>
<td>24</td>
<td>25.3</td>
<td>&lt; 0.001</td>
<td>0.789</td>
<td>0.015</td>
</tr>
<tr>
<td>Allergic rhinitis</td>
<td>23</td>
<td>24.2</td>
<td>0.004</td>
<td>0.642</td>
<td>0.021</td>
</tr>
<tr>
<td>Eczema</td>
<td>15</td>
<td>15.8</td>
<td>0.048</td>
<td>0.018</td>
<td>0.256</td>
</tr>
<tr>
<td>Allergic conjunctivitis</td>
<td>4</td>
<td>4.2</td>
<td>0.454</td>
<td>0.548</td>
<td>0.739</td>
</tr>
</tbody>
</table>

*Phadiatop® positive; fx5® positive; Phadiatop® or fx5® positive.
The majority of participants (81.1%) had a family history of atopy, which agrees with other international studies [20]. The overall rate of atopy (sensitization to aeroallergens or foods or both) in our sample was 67.4%, which is consistent with reports from industrialized countries such as the USA [20]. Of these, 56.4% were sensitized to aeroallergens and 39.0% to foods. Food allergy has been reported to be prevalent in asthmatic children [28,29], to be a risk factor for asthma [29] and to trigger or exacerbate bronchoconstriction in 2%–8.5% of children with asthma [6]. Although we observed a significant association between food allergy and atopic asthma, the actual impact of food allergies in triggering or exacerbating asthma was not assessed in this study.

A high degree of consanguinity has been reported in the parents of asthmatic children in our region (52%) [23]. Although Bahrain is an island and marriage within families is common, our data showed a low rate of consanguineous marriage among the parents of asthmatic children (22.1%). The rate of consanguinity in 1990 in a sample of 500 people was 39.4% [30].
Atopic diseases including allergic rhinitis and eczema, which are known to be highly associated with asthma in children [31–33], were similarly prevalent in our study population. Allergic rhinitis was most prevalent, followed by eczema, while allergic conjunctivitis was least prevalent among our sample. Allergic rhinitis was significantly associated with sensitivity to aeroallergens, while eczema was significantly associated sensitivity to aeroallergens and to foods.

Reference values for total IgE for non-atopic adults vary in different countries [34–36], with high values being reported in the Gulf region [34] compared with Europe [34,36]. These values are generally lower in children than adults and increase with age [37,38]. The range of serum IgE values of our patients was 0–1000 kU/L, mean 113 kU/L. A significant correlation existed between IgE concentrations and atopy, but not with severity of asthma.

The range of absolute eosinophil count was 0–1600 × 10⁶/L and was elevated in 54.8% of our patients. There was a positive relationship between increased absolute eosinophil count and atopy, particularly to aeroallergens; however this did not correlate with severity of asthma. Blood eosinophilia is seen in atopy and is influenced by several conditions including parasitic infections and corticosteroid therapy [39,40]. In many ways health provision in Bahrain shares many of the characteristics of health services in the advanced industrial countries. The infant mortality rate is among the lowest in the Middle East [41] and parasitic infections are uncommon.

In conclusion, 67.4% of asthmatic children in Bahrain were atopic and a high proportion (58%) had their first episode of asthma within their first 2 years. A significant number were sensitized to foods and had other associated atopic diseases, including allergic rhinitis and eczema, but their atopic profile was generally similar to other asthmatic children in the region and worldwide. The prevalence of asthma and the identity of specific allergens in asthmatics in Bahrain are still unknown. We are investigating these parameters.

Acknowledgement

This work was supported by a grant from the Arabian Gulf University.

References


**Correction**


On page S136, column 3, under “Health workforce”, on lines 9 and 12, “Lady Health Visitors” should read “Lady Health Workers”.