Paediatric asthma in North Africa: the Asthma Insights and Reality in the Maghreb (AIRMAG) study

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Introduction

Asthma is the most frequent chronic illness encountered in children. The ISAAC survey has used a standardised methodology to estimate the prevalence of wheezing in the past twelve months in a large number of countries around the world1. Although high prevalence rates were found in Western Europe (16.1%) and North America (24.2%), prevalence in many developing countries was much lower1. Concerning the Maghreb countries of North Africa, three centres in Morocco and one in Algeria participated in the

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ISAAC project, providing prevalence rates of 7.8% in Algeria and 7.5% in Morocco. However, findings such as this only provide a partial picture of the burden of paediatric asthma in this region, due to the limited number of participating centres, which were restricted to urban areas, to the narrow age group concerned (13–14 year olds), and to the fact that the ISAAC study did not attempt to address the issues of asthma severity and management.

Moreover, the fifteen years since the time of the ISAAC study (1994–1995) have seen important demographic and lifestyle changes in the Maghreb that may influence the burden of asthma in children. Indeed a reiteration of the ISAAC study in 1999–2000 revealed a significant increase in the proportion of schoolchildren with asthma in Casablanca and Marrakech. In contrast, earlier studies suggested lower prevalence rates than those observed in the ISAAC study. For example, a survey of secondary schoolchildren in Rabat dating from 1986, in which cases were ascertained by respiratory function tests estimated the cumulative prevalence of asthma to be 3.4±0.9%.3 Another early report from 1984–1985 in the Daira de Chéraga region in the urbanised coastal plain of Algeria provided a very low estimate of the prevalence of paediatric asthma (1.34%).4 A contemporary national Tunisian school survey conducted in 1985 estimated the prevalence of childhood asthma to be 2.4%.5

It is important to update the available information on the burden of paediatric asthma, to extend this to the general population of Maghreb countries, and to collect data on the impact and management of asthma in children in order to plan appropriate allocation of healthcare resources. For this reason, we conducted a general population survey, AIRMAG, to estimate the prevalence, burden, impact and management of asthma based on the methodology of the Asthma Insights and Reality surveys (AIR), which has been widely used over the past decade in other regions of the world. The AIRMAG survey provided prevalence rates for paediatric asthma in a general population sample of children aged under sixteen years, as well as information on the impact of burden of asthma in children in the Maghreb. The present article reports these data, corresponding data for adults being described in detail elsewhere in this supplement.

Methods

This was a cross-sectional epidemiological survey of asthma conducted in a random sample of the general population of Algeria, Morocco and Tunisia between January 2008 and May 2008. The methodology of the study has been described in detail in an accompanying article in this supplement, to which the reader is referred for more information. A brief summary is provided hereunder.

A sample of the general population in each of the three participating countries was generated using a random stratified sampling method based on randomly-generated lists of telephone numbers. The target sample of the study consisted of 10,000 individuals in each country. The study population was divided into an adult group (aged sixteen and over) and a paediatric group (less than sixteen years).

Households were contacted by ringing each number in the list consecutively. Each number was dialled up to ten times in case of non-response before being considered a contact failure. After ten calls, outcomes were categorised as interview, formal refusal, not a valid number (out of service, not a household, or no response after ten calls). Telephone interviews were conducted by seventeen local interviewers (seven for Tunisia, five for Morocco and five for Algeria). Interviewees could choose the language in which they preferred to respond. The CAPI (Computer Assisted Personal Interview) method and CONVERSO® software (developed by Conversoft® France) were used for the interview. Respondents were first asked if they were willing to participate in a questionnaire about health in general. If so, information was requested on the household structure (number in family: members, gender and age). The household member to answer the questionnaire was then selected randomly by the CAPI. In the case of children, the parent answered the questionnaire.

Two screening questions were asked to identify subjects fulfilling diagnostic criteria for asthma, relating to occurrence of asthma symptoms and use of asthma treatments. Subjects responding positively to either of the questions were considered as having asthma for the purposes of this study. During a second step, subjects who met these criteria were then questioned in more detail to collect information on the frequency and severity of symptoms, impact on activities of everyday life, treatments, monitoring, asthma control and knowledge about asthma. Since the Asthma Control Test has not been validated in children, information on asthma control was derived indirectly from answers to questions relating to the GINA criteria for asthma control, however it was not possible to evaluate pulmonary function, since respiratory function testing was not possible in the context of a general population study such as AIRMAG.

For the five remaining criteria, if all were fulfilled the subject was classified as controlled, if one or two criteria were not fulfilled the subject was classified as partially controlled and if more than two criteria were unfulfilled the subject was classified as uncontrolled. Severity was assessed using an adaptation of the severity score based on the classification put forward by the GINA (Global Initiative on Asthma), that had been used in the previous AIR studies.

Inter-group comparisons were performed with the \(\chi^2\) test or Fisher’s exact test for categorical variables and Student’s \(t\)-test for continuous variables (corrected using the Welch-Satterthwaite equation in case of heterogeneous variance). Two-sided tests were used throughout and a probability level of \(p<0.05\) was considered significant. All data were controlled, validated and analysed centrally (Kappa Santé, Paris, France) using SAS software, version 9.1 (SAS Institute, Cary, USA).

Results

Study population

The number of subjects available for interview ranged from 10,015 in Algeria to 10,284 in Tunisia. These included 2,589
Asthma history and context

Children with asthma had received a diagnosis four years previously (median) at the age of two years (median). The diagnosis had been made by a specialist in the majority of cases (61.4%). Although this was the case in all three Maghreb countries, it was particularly remarkable in Morocco, where only eleven children had been diagnosed by a general practitioner (Table 1).

The most frequent initial presenting symptoms which had led to the diagnosis of asthma were persistent cough (50.8% of children), breathlessness (43.1%) and wheezing (38.7%). However, some differences were seen between countries with, for example, persistent cough being cited for 73.0% of children in Morocco and breathlessness for 68.5% of children in Tunisia. Around three-quarters of the children presented seasonal asthma and 43.2% had a smoker in their household. Exposure to tobacco smoke was notably high in Tunisia (53.3% of children). The overall health status of the children was considered good to excellent in 48.4% of cases and bad or very bad in seventeen children only (6.9%). Asthma symptoms were considered to have improved since diagnosis in 78.9% of children (Table 1).

Prevalence of asthma in children

Crude prevalence rates for paediatric asthma in a general population sample of children aged under sixteen years were 4.1% [95% confidence intervals: 3.3% to 4.8%] for Algeria, 4.4% [95% CI: 3.5% to 5.3%] for Morocco and 3.5% [95% CI: 2.9% to 4.2%] for Tunisia. In Algeria and Tunisia, asthma was more common in boys than in girls, whereas in Morocco, girls were more frequently affected (Fig. 2). No major differences in prevalence were observed with respect to age, although in all three countries, the five to nine year age group was the most affected (Fig. 2).

Current asthma features

The majority (155 children; 63.0%) had experienced a severe asthma attack, defined as a severe bout of coughing, breathlessness, chest tightness or wheezing, in the previous year. This proportion ranged from 57.1% (52 children) in Tunisia, through 60.8% (45 children) in Morocco to 71.6% (58 children) in Algeria. However, the frequency of such severe attacks in the previous year was less than one per month for the majority of children in all countries (63.7% overall).
Fig. 2. Age and gender-specific prevalence rates for asthma in three participating countries with their 95% confidence intervals.

The most frequent respiratory symptoms reported in the children over the previous four weeks (Table 2) were persistent cough (56.9% of children overall), breathlessness (49.6%), persistent colds (47.2%) and blocked nose (46.4%). Overall, 59.6% of children experienced episodes of breathlessness at least once a week, and 43.0% had been wakened during the night by respiratory symptoms at least once a week (Fig. 3). Although no obvious differences in symptom presentation between the three participating countries were observed, the frequency of breathlessness and nocturnal awakenings appeared somewhat lower in Tunisia and somewhat higher in Morocco. For breathlessness, this between-country difference was significant \((p < 0.01; \text{Fisher’s exact test})\).

Asthma severity was rated using an algorithm based on the GINA severity criteria and categorised as severe

Table 2. Respiratory symptoms in the previous four weeks

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Algeria (N = 82)</th>
<th>Morocco (N = 74)</th>
<th>Tunisia (N = 92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent cough</td>
<td>45 (54.9%)</td>
<td>43 (58.1%)</td>
<td>53 (57.6%)</td>
</tr>
<tr>
<td>Breathlessness</td>
<td>38 (46.3%)</td>
<td>39 (52.7%)</td>
<td>46 (50.0%)</td>
</tr>
<tr>
<td>Persistent cold</td>
<td>42 (51.2%)</td>
<td>41 (55.4%)</td>
<td>34 (37.0%)</td>
</tr>
<tr>
<td>Blocked nose</td>
<td>44 (53.7%)</td>
<td>34 (45.9%)</td>
<td>37 (40.2%)</td>
</tr>
<tr>
<td>Wheezing</td>
<td>34 (41.5%)</td>
<td>36 (48.6%)</td>
<td>40 (43.5%)</td>
</tr>
<tr>
<td>Respiratory problems</td>
<td>49 (59.8%)</td>
<td>31 (41.9%)</td>
<td>28 (30.4%)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>37 (45.1%)</td>
<td>32 (43.2%)</td>
<td>27 (29.3%)</td>
</tr>
<tr>
<td>Rhinitis</td>
<td>26 (31.7%)</td>
<td>42 (56.8%)</td>
<td>20 (21.7%)</td>
</tr>
<tr>
<td>Nocturnal awakenings</td>
<td>28 (34.1%)</td>
<td>28 (37.8%)</td>
<td>26 (28.3%)</td>
</tr>
<tr>
<td>Cough with phlegm</td>
<td>20 (24.4%)</td>
<td>25 (33.8%)</td>
<td>25 (27.2%)</td>
</tr>
<tr>
<td>Bronchitis</td>
<td>20 (24.4%)</td>
<td>12 (16.2%)</td>
<td>11 (12.0%)</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>1 (1.2%)</td>
<td>17 (23.0%)</td>
<td>16 (17.4%)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>5 (6.1%)</td>
<td>9 (12.2%)</td>
<td>4 (4.3%)</td>
</tr>
<tr>
<td>None</td>
<td>4 (4.9%)</td>
<td>1 (1.4%)</td>
<td>2 (2.2%)</td>
</tr>
</tbody>
</table>

* More than one response was possible.
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Fig. 3. Frequency of breathlessness (left) and nocturnal awakenings (right) in the previous four weeks. Data are presented as the percentage of respondents.

![Graph showing frequency of breathlessness and nocturnal awakenings](image)

**Fig. 3.** Frequency of breathlessness (left) and nocturnal awakenings (right) in the previous four weeks. Data are presented as the percentage of respondents.

![Graph showing clinical severity of asthma](image)

**Fig. 4.** Asthma severity. Data are presented as the percentage of respondents.

![Graph showing handicap due to asthma](image)

**Fig. 5.** Handicap due to asthma. Data are presented as the percentage of respondents.

![Table showing asthma impact](image)

**Table 3. Asthma impact**

<table>
<thead>
<tr>
<th></th>
<th>Algeria (N = 82)</th>
<th>Morocco (N = 74)</th>
<th>Tunisia (N = 92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sport and leisure</td>
<td>N = 45</td>
<td>N = 42</td>
<td>N = 73</td>
</tr>
<tr>
<td>Normal physical activity</td>
<td>N = 43</td>
<td>N = 41</td>
<td>N = 81</td>
</tr>
<tr>
<td>Professional activities</td>
<td>N = 6</td>
<td>N = 18</td>
<td>N = 37</td>
</tr>
<tr>
<td>Social activities</td>
<td>N = 57</td>
<td>N = 48</td>
<td>N = 83</td>
</tr>
<tr>
<td>Sleep</td>
<td>N = 75</td>
<td>N = 63</td>
<td>N = 88</td>
</tr>
<tr>
<td>Lifestyle</td>
<td>N = 68</td>
<td>N = 32</td>
<td>N = 79</td>
</tr>
<tr>
<td>Household tasks</td>
<td>N = 14</td>
<td>N = 11</td>
<td>N = 19</td>
</tr>
</tbody>
</table>

*Data represent the number (%) of subjects providing information on the given item (N) who replied ‘very limited’ or ‘quite limited’ on a five-point Likert scale.*

Impact of asthma

During the previous year, one hundred children (40.7%; 33 children in Algeria, 35 in Morocco and 32 in Tunisia) had missed school at least once because of their asthma. The mean number of days missed ranged from 4.9±5.9 in Tunisia to 9.9±11.6 in Algeria. Of the 49 children who were reported to participate in sports regularly, 17 (34.7%) were unable to do so at least once in the previous month due to their asthma.

Overall, 176 children (73.0%) were considered to be handicapped in their everyday activities always or most of the time (Fig. 5). Only 24 children (9.9%) were rarely or never handicapped. There was some suggestion that children in Tunisia were less handicapped than the others, but this difference was not statistically significant.

Significant impact of asthma was reported over a wide variety of activities (Table 3).
Asthma control

Asthma control was approached through a series of questions relating to five of the six GINA control criteria. Overall, only 7.6% [95% CI: 4.8–11.8%] of children were considered to be controlled and 46.2% [39.9–52.6%] to be uncontrolled (Table 4). Asthma control was best in Tunisia and worst in Morocco. This inter-country difference was significant (\(p = 0.03\); \(\chi^2\) test).

| Table 4. Asthma control determined using an algorithm based on the GINA criteria* |
|---------------------------------|------------------|------------------|
| Asthma control level            | Algeria (N = 82) | Morocco (N = 74) | Tunisia (N = 92) |
| Controlled                      | 6 (7.9%)         | 2 (2.9%)         | 10 (11.0%)       |
| Partially controlled            | 37 (48.7%)       | 25 (36.2%)       | 47 (51.6%)       |
| Uncontrolled                    | 33 (43.4%)       | 42 (60.9%)       | 34 (37.4%)       |
| Missing data                    | 6                | 5                | 1                |

* Data represent the number (%) of children with asthma in each control category. If any criterion was not determined, the asthma control was not attributed and the individual was classified as missing data.

Use of healthcare resources

Thirty children (12.2%) had required hospitalisation for their asthma in the previous year and 81 had made at least one visit to an emergency department (32.9%). Both hospitalisation and emergency department visits were around twice as frequent in Algeria than in Morocco and Tunisia (Table 5). Moreover, for the majority of children (89.0%), it was necessary to call out a physician due to an asthma attack on multiple occasions (median: three times in the last twelve months).

Most children consulted a private community practice for their asthma and were followed by a specialist. Recourse to public community care providers (community hospitals, rural dispensaries and polyclinics) was highest in Algeria (28.8%). In Morocco, more children attended private healthcare providers and consulted specialists than in the other two countries. The frequency of physician consultation for asthma was higher in Algeria, with 42.9% of children consulting a physician at least once a month. In Morocco and Tunisia, <25% consulted this frequently, and over a third of children only consulted...
Table 6. Treatments for asthma

<table>
<thead>
<tr>
<th></th>
<th>Algeria (N = 82)</th>
<th>Morocco (N = 74)</th>
<th>Tunisia (N = 92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-acting β-agonists</td>
<td>37 (45.1%)</td>
<td>55 (74.3%)</td>
<td>39 (42.4%)</td>
</tr>
<tr>
<td>Long-acting β-agonists + corticosteroids</td>
<td>2 (2.4%)</td>
<td>6 (8.1%)</td>
<td>9 (9.8%)</td>
</tr>
<tr>
<td>Inhaled corticosteroids only</td>
<td>9 (11.0%)</td>
<td>17 (23.0%)</td>
<td>29 (31.5%)</td>
</tr>
<tr>
<td>Oral corticosteroids</td>
<td>28 (34.1%)</td>
<td>24 (32.4%)</td>
<td>18 (19.6%)</td>
</tr>
<tr>
<td>Oral antihistamines</td>
<td>9 (11.0%)</td>
<td>22 (29.7%)</td>
<td>17 (18.5%)</td>
</tr>
<tr>
<td>Other treatments</td>
<td>24 (29.3%)</td>
<td>26 (35.1%)</td>
<td>55 (59.8%)</td>
</tr>
</tbody>
</table>

* Multiple responses were possible.

Discussion

The overall prevalence rate for paediatric asthma in the general population of the three Maghreb countries ranged from 3.5% in Tunisia to 4.4% in Morocco. These rates are generally lower than those reported in the ISAAC study, performed in the early 1990s. The latter study reported twelve-month prevalence rates for wheeze in the 13–14 year old age group of 7.8% for Algiers, 9.9% for Casablanca, 5.6% for Marrakech and 6.8% in Rabat. The younger 6–7 year-old age group were not evaluated in the Maghreb centres of the ISAAC study.

In this sample of children with asthma in the Maghreb, the principal finding was the relatively high impact of asthma on their lives, three-quarters of the sample being handicapped by their asthma all or most of the time, one quarter fulfilling the GINA severity criteria for severe persistent asthma and one third needing to be taken to an emergency department because of their asthma in the previous year. Forty percent took time off school in the previous year because of their asthma and fifty percent had to cancel planned sports
activities in the previous month. Given this unsatisfactory state of affairs, it is remarkable that for four out of five children, asthma was considered to have improved since first diagnosed.

The most frequent asthma symptoms reported were breathlessness and wheezing, with the majority of children experiencing an episode of breathlessness at least once a week. In addition, other respiratory symptoms were frequent in these children, notably colds and related symptoms, as well as persistent cough. This is consistent with a wealth of evidence for an association between rhinitis and asthma.

Even though they did not appear to present more frequent or severe symptoms than the other children in the study, the children from Algeria were hospitalised and taken to an emergency department twice as often as children from Morocco or Tunisia. This may reflect the more important role played by the public healthcare sector, with access to care being in general free, in Algeria compared to the other two countries. This could also explain certain of the other inter-country differences observed, such as the higher use of public community-based care structures in Algeria, and the younger age at which asthma was diagnosed.

The severity of asthma identified in this study may well be underestimated. Indeed, the algorithm for the definition of severity assigns an overall severity grade on the basis of the most severe rating reported for any on the five items considered. Since data on two of these items (exercise-induced symptoms and symptom frequency during atypical weeks) were not collected in the AIRMAG study, the overall severity assignment was made on the basis of only three items (frequency of daytime symptoms, frequency of night-time symptoms and frequency of severe episodes in the last twelve months). It is likely that some children would have fulfilled criteria for a more severe grade on one of the missing items and thus may be assigned to an inappropriately low severity grade on the basis of the items actually evaluated. It is of interest that some differences in the distribution of severity grades were apparent between countries, notably for children in Tunisia who appeared to present less severe asthma. This may relate to differences in asthma management between countries (see below).

The major impact of asthma in children from the Maghreb that is apparent in this study, for example in the relatively high rates of hospitalisation and emergency department visits, is likely to reflect unsatisfactory asthma control. We have attempted to address this issue by evaluating the different variables contributing to the six criteria used to define the level of asthma control in the GINA guidelines. It was not possible to use the Asthma Control Test to assess control, as was done for adult participants in the AIRMAG study, since this questionnaire has not been validated in children. Using the GINA-based algorithm, we found less than one child in twelve to be controlled and nearly half to be uncontrolled. Asthma control appeared to be best in Tunisia. Nonetheless, the level of control in this study is likely to be over-estimated since pulmonary function testing, which is included in the GINA criteria, was not evaluated in the AIRMAG study. It has been shown previously that exclusion of this criterion and reliance on symptoms only when assessing asthma control in children results in a significant proportion of poorly controlled children being incorrectly identified as controlled.

Several studies have shown convincingly that asthma control can be improved by appropriate treatment. For example, in a prospective observational study of 310 newly-diagnosed patients in seven centres in developing countries, including two centres in Algeria and one in Morocco, managed with a standardised protocol based on GINA guidelines and treated with inhaled corticosteroids, the proportion of patients falling into the lowest severity grade (intermittent) rose from 11% to 55%. In the AIRMAG study, however, less than one-third of the children assessed were treated with inhaled corticosteroids. Cost has been reported to limit accessibility to these medications in many low- and middle-income countries, but recent GINA reports have emphasised the need to improve accessibility to essential drugs for the management of asthma in such countries as a means to lowering barriers to achieving satisfactory asthma control. The relatively high level of use of oral corticosteroids may reflect the severity and poor control of asthma in children from the Maghreb.

Other management strategies recommended by GINA, which have less important cost implications, were also found to be used infrequently in the management of children with asthma in the Maghreb. These include the planning of regular follow-up visits with the physician, the drafting of a written action plan for handling severe attacks, use of a peak flow meter and regular pulmonary function testing. This situation does not seem to have improved since the need for improvement in these areas was noted over a decade ago. All these actions contribute to monitoring the care of the child with asthma and permit timely adaptation of treatment whenever necessary. In the absence of pulmonary function testing, asthma control is likely to be over-estimated if evaluated from symptoms alone. It is noteworthy that physician consultations were more often planned in advance, awareness of peak flow meter use higher, and prescription of inhaled corticosteroids more frequent, in Tunisia than in the other countries, which may contribute to the apparently lower severity of asthma and superior asthma control in Tunisian children.

Finally, exposure to tobacco smoke causes children to develop asthma and aggravates symptoms. We found that 43.2% of children with asthma in the AIRMAG population had a smoker living with them in the household. This is a higher proportion than smoking rates in the general population (25.2% in Algeria, 18.1% in Morocco and 34.8% in Tunisia), reinforcing the association between passive smoking and childhood asthma. There is clearly a need to highlight the potential impact of smoking on children’s health, particularly with regard to asthma, in public health campaigns aimed at smoking prevention in the Maghreb.

In conclusion, asthma has a major impact on the lives of children with asthma in the Maghreb. This could be attenuated by more widespread application of improved standards of care, for example as promoted in the GINA guidelines. It is necessary to educate both physicians and people caring for children with asthma on the importance of providing appropriate care and on the benefits for children with asthma that could be achieved in this way.
Conflicts of interest

AEH, MAK and HF are employees of GlaxoSmithKline Laboratories, who funded the AIR research programme and market a number of treatments for asthma. AB, HB, MEF, SN, ST and NY have received consultancy fees in connection with this study from GlaxoSmithKline Laboratories, who funded the AIR research programme and market a number of treatments for asthma. NT is a director of Kappa Santé, the clinical and epidemiological research company who implemented the AIRMAG study on behalf of GlaxoSmithKline Laboratories, who funded the AIR research programme and market a number of treatments for asthma.

References