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

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KEYWORDS
Asthma;
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Summary
Background: Bronchial asthma is the most frequent chronic respiratory disease in both adults and children. The prevalence and burden of asthma vary considerably between different regions of the world. Information on asthma in Africa is fragmentary and relatively old.
Objective: The objective of this cross-sectional epidemiological survey was to determine the prevalence and burden of asthma in the North African countries of Algeria, Morocco and Tunisia using the methodology developed in the Asthma Insights and Reality (AIR) programme.
Methods: A general population sample was generated using a stratified sampling method based on randomly-generated lists of telephone numbers. The target sample consisted of 10 000 households in each country, which were contacted by telephone. A structured interview was proposed. Two screening questions were asked to identify subjects with asthma. Subjects who met these criteria were then questioned in more detail about their asthma.
Results: Of 30 350 households contacted, 1 090 subjects with asthma were identified of whom 872 provided complete data. The age- and gender-adjusted prevalence of asthma was 3.45% [95% CI: 3.09–3.80%] in Algeria, 3.89% [95% CI: 3.52–4.27%] in Morocco and 3.53% [95% CI: 3.18–3.89%] in Tunisia. Prevalence was highest in children and older adults, and in urban areas. Annual incidence rates ranged between 28/10 000 in Tunisia and 46/10 000 in Algeria. 74.3% of adults reported being handicapped by their asthma all or most of the time, 26.4% reported a visit to a hospital emergency department in the previous year and 23.9% absence from work or school due to asthma. 48.0% reported that their sleep was very or quite disturbed by asthma.
Conclusions: The prevalence of asthma in the Maghreb countries is moderate, but its impact is high.
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Introduction

Bronchial asthma is the most frequent chronic respiratory disease in both adults and children. A recent report [1] on the global burden of asthma published by the Global Initiative for Asthma (GINA) estimated that asthma affects around 300 million people in the world, with the number of disability-adjusted life years lost due to asthma estimated at around 15 million per year, and accounting for about 1 in every 250 deaths worldwide. The direct and indirect medical costs associated with asthma are substantial.

In the early 1990s, two large international surveys conducted in the general population described in detail the prevalence and impact of asthma in adults and children. These were the European Community Respiratory Health Survey (ECRHS) [2], which evaluated adults, and the International Survey of Asthma and Allergy in Children (ISAAC) [3,4] studies. More recently, a series of surveys, collectively constituting the Asthma Insights and Reality (AIR) programme, have been performed in a number of countries using a standardised protocol [5]. As well as collecting data on prevalence and burden, the AIR surveys also collected data on asthma control as determined using the GINA guidelines, on management and treatment, and on perceptions and understanding of asthma. The different AIR surveys were performed in the United States in 1998 [6], in Canada in 1999 [7], in Western Europe in 1999 [8], in the Asia-Pacific region [9] and in Japan [10] in 2000, in Central and Eastern Europe in 2001 [5], and in Latin America [11], Australia [12] and Turkey [13] in 2003 and in several Middle-East countries in 2007 [14,15]. The Japanese study was reiterated in 2005 [16].

These surveys and others have revealed major differences in the prevalence of asthma between different regions of the globe, ranging from <2.5% in Eastern Asian countries such as China and Indonesia to >10% in the British Isles, Australia, Brazil and Canada [1]. As well as these regional differences, there is also evidence for temporal changes in the prevalence of asthma, with an increase in prevalence in both children [17] and adults [18,19] being noted in many countries over the last three decades. Although improved case ascertainment may contribute to this increase, environmental factors such as urbanisation and biological factors such as atopic sensitisation may also be involved [20,21].

In many regions of the world, notably Africa, there is a paucity of recent information on the epidemiology of asthma. Concerning the Maghreb countries of North Africa, one urban centre in Algeria (Algiers) and three in Morocco (Rabat, Casablanca and Marrakech) participated in the ISAAC survey in 1994–1995. In this survey, twelve-month prevalence rates for wheeze in the 13–14 year old age group were 7.8% in Algeria and 7.5% in Morocco [3]. The ISAAC III study also found that prevalence rates in Africa were around twice as high in urban areas compared to rural areas. A number of older studies conducted in the 1980s in individual centres or regions of all three Maghreb countries identified lower prevalence rates of paediatric asthma, ranging from 2% to 5% [22], although more recent studies revealed rates, ranging from 8% to 10% [22], consistent with the ISAAC study. It has been postulated that this marked increase in prevalence may be due to 'Westernisation' of Maghreb society during this period [22].

In adults, even less data is available. A study in the Algiers region performed in 1986 reported an estimated prevalence of respiratory symptoms among individuals aged 7–70 years of 2.3% [23]. In 1990, Algiers participated in the ECRH survey, and a prevalence for diagnosed asthma in 20–44 year olds of 3.0% percent was reported. This was one of the lowest prevalence rates detected in any of the countries participating in the ECRH survey [2]. More recently, a survey conducted in the Zeralda district of Algeria (coastal plain) reported a cumulative prevalence of 1.8% in the total population (all ages), although the authors pointed out that the sampling method used did not ensure the representativity of the study sample [24]. To our knowledge, there is no published data on the prevalence of asthma in adults in either Morocco or Tunisia.

Given the pertinence of asthma as a public health issue worldwide [1], it is important to collect reliable and up to date information on the epidemiology of asthma in North African countries. To this end, we have implemented a large general population survey (AIRMAG) of the prevalence, burden, management and control of asthma in the three countries of the Maghreb using a comparable approach to that used in the previous AIR surveys. This article describes the methodology of the AIRMAG study and presents the principle results obtained concerning the prevalence of asthma and its impact in adults.

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.

Study sample

A sample of the general population in each of the three participating countries was generated using a random stratified sampling method. A random list of landline or mobile telephone numbers was constituted as an initial step by generating random numbers in the format of telephone numbers covering both fixed and mobile telephone formats. Given that the proportion of all possible telephone numbers that was actually attributed differed between countries, it was necessary to generate different sized sets of random numbers (largest in Tunisia and smallest in Morocco) in order to ensure meeting the target sample of attributed numbers. 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 bring considered a contact failure. In order to optimise chances of success, calls were made on different days of the week, including week-ends and at different times, including evenings. 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).

Respondents were asked if they were willing to participate in a questionnaire about health in general. The process continued until a target sample of 10 000 individuals agreeing to participate in each country was reached. Real-time stratification was performed in order to ensure representativity compared to the general population

Table 1. Screening questions used to identify individuals with asthma

1.	Have you had an asthma attack or asthma symptoms in the previous twelve months?
2.	Have you taken medication for asthma attacks (eg pills, inhaled powders, aerosols etc) in the previous twelve months?
2a.	Have you taken ventolin in the previous twelve months?

of each country, whereby interviewers were expected to respect a fixed quota of subjects fulfilling predefined sociodemographic criteria for a given stratum. A crossed stratification was used for ensuring representativity by age and gender and a marginal stratification for ensuring representativity by region. The structure of the strata were defined using national population data obtained from the African Development Bank Group [25] and the most recent national census data.

The first question of the interview referred to the characterisation of the household structure (number in family: members, gender and age). The household member to answer the questionnaire was then selected randomly by the CAPI. If this individual was present and available, the interview was completed there and then. Otherwise, an appointment was made for a subsequent time.

For the purposes of the analysis, the study population was divided into an adult group (aged sixteen and over) and a paediatric group (under sixteen years). For the paediatric group, a parent answered the questionnaire on behalf of the identified child.

Data collection

Telephone interviews were conducted by seventeen local interviewers (seven for Tunisia, five for Morocco and five for Algeria). The interviewers were students who had been trained about asthma and the study protocol and on telephone interview technique. Interviewers spoke French and the local dialectal form of Arabic appropriate for the region. Interviewees could choose the language in which they chose to respond. Since certain berberophone populations in the Maghreb may not feel comfortable responding in Arabic, the interviewer could conduct the telephone interview in French or in Berber language if necessary. The CAPI (Computer Assisted Personal Interview) method and CONVERSO® software (developed by Conversoft® France) were used for the interview. Questions in the interview were generally closed and the interviewers were not required to interpret the replies given. The interview lasted from fifteen to fifty minutes. No specific gifts or incentives were offered to participating subjects.

Prior to initiating the survey, the questionnaires were initially translated from French to local dialectal Arabic by the local expert of each country. A feasibility study was then performed to assess comprehension, acceptability and relevance of the questionnaire. In this, the questionnaires were administered to a general population sample in order to estimate potential response rates and to ensure acceptability of health-related questionnaires and the language proposed. Items that could potentially be ambiguous or poorly understood were rephrased accordingly.

In a first step, sociodemographic data was collected to ensure that the respondent matched an open stratum. If this was the case, two screening questions were asked to identify subjects fulfilling diagnostic criteria for asthma (Table 1). During the course of the study, a specifier for the second question was added (Question 2a) and interviewees were specifically asked about use of short-acting β-mimetics (ventolin has become a general term for asthma relief medication in these countries). 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.

Asthma control was assessed in two ways. Firstly, the Asthma Control Test (ACT) [26,27] was administered. This is a questionnaire containing five items which can each be rated on a five-point Likert scale. Since the ACT has only been validated in patients aged over twelve, this questionnaire was only proposed to subjects in the adult subpopulation. The second assessment was based on the GINA criteria for asthma control [28]. Data relating to the GINA criteria were extracted from the questionnaire and used to assign subjects to one of three levels of control (controlled, partly controlled and uncontrolled).

Severity was assessed using an adaptation of the GINA-based severity score used in the previous AIR studies [5]. Briefly, one of four clinical severity grades (intermittent asthma, mild persistent asthma, moderate persistent asthma and severe persistent asthma) was assigned to each patient based on frequency of the asthma symptoms. The original severity score contains five items. However, data on the two last items (exercise-induced symptoms and symptom frequency during a typical week) were not collected in the AIRMAG study. The overall severity grade assigned corresponded to the most severe grade reported for any individual item. Subjects reporting severe episodes every day over the previous years were systematically assigned to the 'severe persistent' severity grade.

For certain interviewees, the interview was repeated one week later in order to test the reproducibility of the ACT. These data are presented in the article describing the psychometric validation of the ACT elsewhere in this supplement [29].

Statistical analysis

Crude prevalence rates were adjusted for age and gender by weighting each subject to take into account the actual structure of age and gender in the national population. Age- and gender-specific prevalence rates are provided with their 95% confidence intervals (CI). Adjusted prevalence rates were determined for each region of the three participating countries. This adjustment was necessary to take into account the relative numbers of adults and children in each country, since the adult subgroup was over-represented compared to the paediatric subgroup.

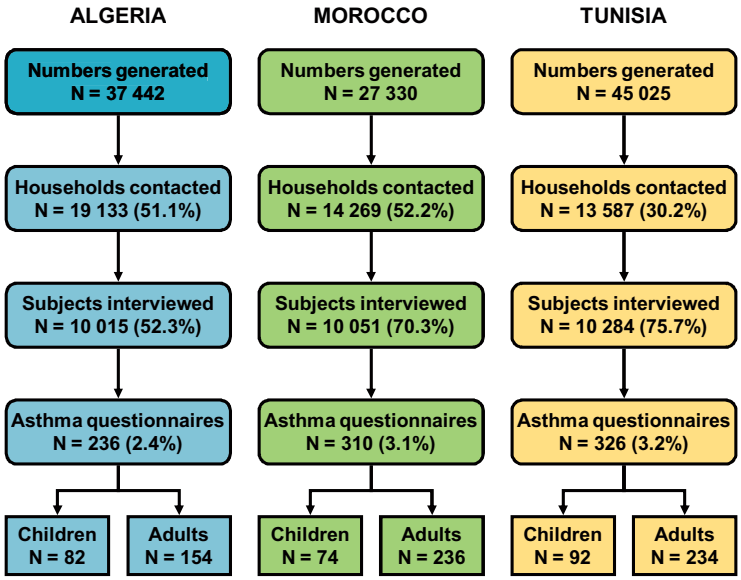

Fig. 1. Structure of the study sample in the three participating countries. Percentages are calculated with respect to the previous box on the diagram in each case.

Incidence rates were estimated from the proportion of subjects completing the asthma questionnaire who reported having received a diagnosis of asthma in the previous twelve months. This proportion was then extrapolated to the subjects fulfilling criteria for asthma with the screening questionnaire who did not complete the asthma questionnaire in order to generate the total number of subjects in the sample who fulfilled criteria for asthma and who had received a diagnosis within the past year. This number was used to compute the estimated incidence rate, which was adjusted for age and gender to reflect the demographic structure of the general population in each of the three countries.

Inter-group comparisons were performed with the χ^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 structure of the study sample is illustrated in Fig. 1. In order to achieve the target sample size of 10 000 interviewees in each of the three participating countries, it was necessary to dial a total of 109 797 telephone numbers, of which 62 781 (67.2%) were not exploited (approximately half the numbers in Algeria and Morocco and around two-thirds in Tunisia). The principal reasons for this were number not in service (from 4.9% in Morocco to 36.4% in Tunisia), lack of reply after ten calls (from 11.2% in Tunisia to 21.7% in Morocco), business addresses (from 3.3% in Algeria to 8.6% in Morocco) and quota exceeded (5.1% in Algeria to 13.7% in Tunisia). For the 47 016 numbers exploited, the respondent refused to participate in the study in 16 666 cases (35.4%). Refusal rates varied from 24.3% in Tunisia and 29.7% in Morocco to 47.7% in Algeria. For the remainder, an interview was proposed to a randomly selected household member, thus generating the study sample of 30 350 subjects.

One thousand and ninety subjects interviewed fulfilled the criteria for asthma in the screening questionnaire and were proposed the opportunity to participate in the second part of the study and to answer detailed questions on asthma. Eight hundred and seventy-two patients accepted (80.0%) and provided complete data. Refusal rates were again lowest in Tunisia (11.7%) and highest in Algeria (30.2%).

Prevalence of asthma in the general population

In the entire study sample, 1 090 subjects (3.6%) replied in the affirmative to one of the two screening questions and were thus considered to have asthma. Of these subjects, 774 (71.0%) reported asthma symptoms or attacks in the previous year and 849 (77.9%) reported use of asthma medications. Only 34 subjects (3.1%) were identified only on the basis of a positive reply to the specific question on use of short-acting β-mimetics. The crude prevalence of asthma was similar in the three Maghreb countries (3.4% in Algeria, 3.8% in Morocco and 3.6% in Tunisia).

The overall age- and gender-adjusted prevalence of asthma was 3.45% [95% CI: 3.09–3.80%] in Algeria, 3.89% [95% CI: 3.52–4.27%] in Morocco and 3.53% [95% CI: 3.18–3.89%] in Tunisia. Age- and gender-specific prevalence rates are presented in Fig. 2. In Algeria, prevalence rates in males and females were comparable, but large differences were observed in the prevalence of asthma between age groups, this being highest in children aged under sixteen and in the oldest group (>54 years). In contrast, in Morocco, prevalence was significantly higher in females than in males,

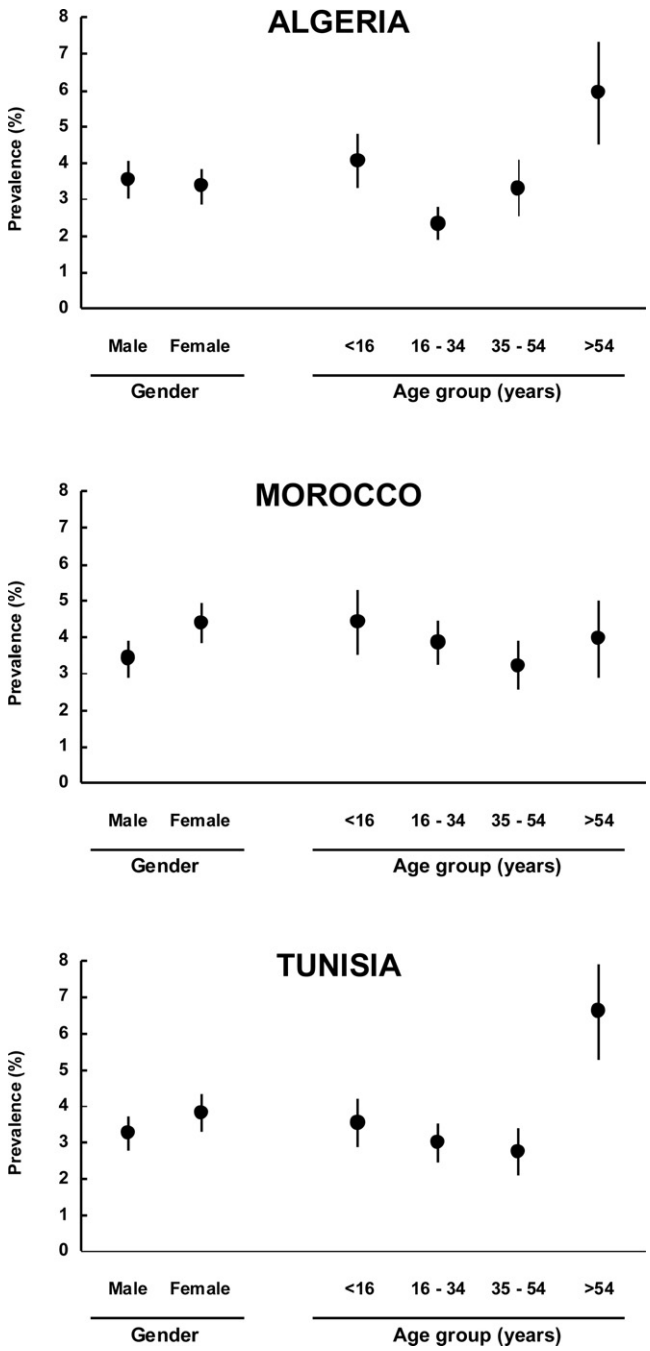

Fig. 2. Age- and gender-specific prevalence rates for asthma in three participating countries with their 95% confidence intervals.

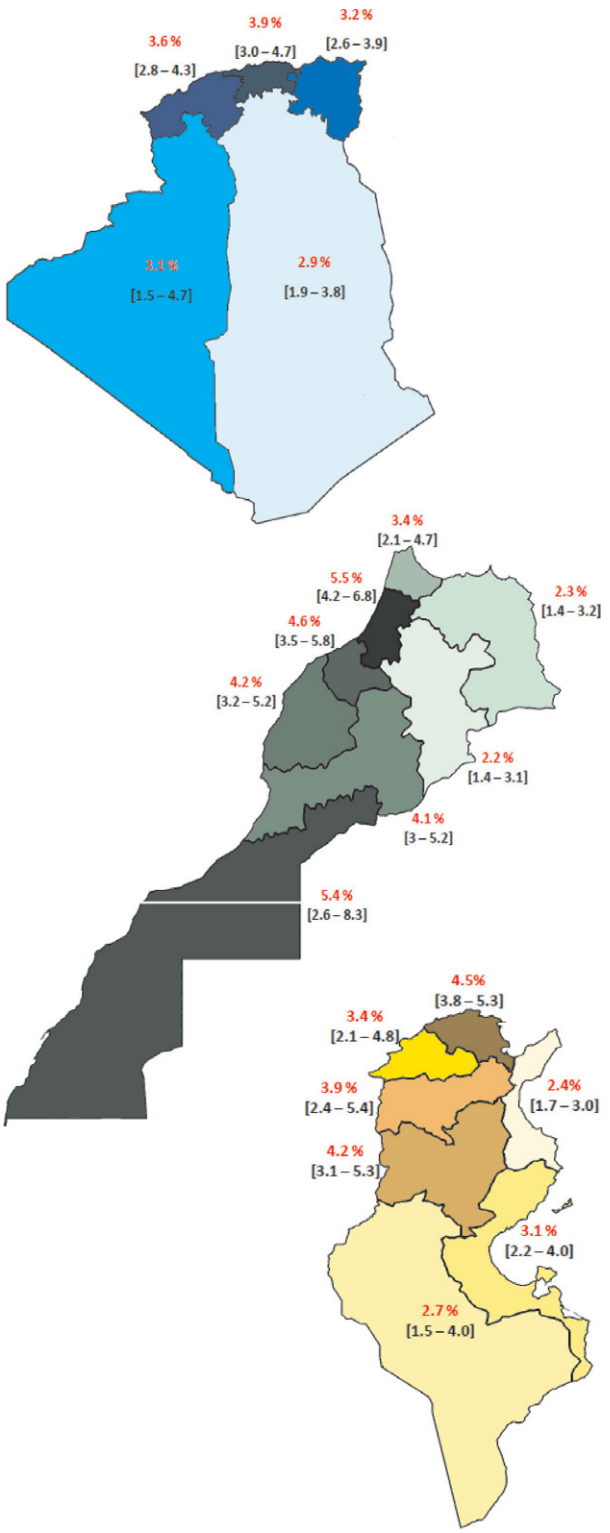

Fig. 3. Regional age- and gender-adjusted prevalence rates for asthma in three participating countries with their 95% confidence intervals.

but age differences were modest. The pattern observed for Tunisia was intermediate between those seen in the other two countries, with only the > 54 year age group showing a markedly higher prevalence of asthma.

Some regional variation in asthma prevalence rates was observed in all three countries (Fig. 3). In Algeria, the highest rates were observed in the densely-populated central coastal strip around Algiers and lowest in the desert of the South. In Morocco, prevalence was again higher in the densely-populated central coastal strip (Rabat, Casablanca) than in the mountainous regions of the East and South, although the highest rates of all were observed in the Saharan South. In Tunisia, prevalence was higher in the more urbanised North than in the Saharan South.

During the interview, subjects were asked whether they had ever received a diagnosis of asthma. This was the case for 306 subjects in Algeria (3.1%), 259 in Morocco (2.6%) and 373 in Tunisia (3.1%).

Table 2. Characteristics of adult subjects with asthma identified in the survey.

	Algeria (N = 154)	Morocco (N = 236)	Tunisia (N = 234)
Age			
Mean±SD	40.3±17.1	6.5±16.8	44.3±20.3
Median [Range]	39 [16–90]	32 [16–80]	42 [16–100]
Gender			
Women	88 (57.1%)	142 (60.2%)	140 (59.8%)
Men	66 (42.9%)	94 (39.8%)	94 (40.2%)
Number of household members (mean±SD)	4.9 (± 2.1)	4.3 (± 1.7)	3.8 (± 1.8)
Smoking status			
Active smoker	6 (4.0%)	10 (4.4%)	27 (12.2%)
Ex-smoker	21 (14.1%)	17 (7.5%)	44 (19.9%)
Passive smoker*	51 (34.2%)	62 (32.3%)	111 (50.5%)
Health status			
Excellent	9 (5.9%)	10 (4.3%)	10 (4.3%)
Very good	12 (7.8%)	11 (4.8%)	10 (4.3%)
Good	38 (24.8%)	78 (33.9%)	61 (26.1%)
Average	61 (39.9%)	117 (50.9%)	122 (52.1%)
Poor	25 (16.3%)	9 (3.9%)	18 (7.7%)
Very poor	8 (5.2%)	5 (2.2%)	13 (5.6%)
Other comorbidities			
Diabetes	13 (8.4%)	10 (4.2%)	19 (8.1%)
Hypertension	19 (12.3%)	13 (5.5%)	53 (22.6%)
Others	20 (13.0%)	31 (13.1%)	28 (12.0%)

*Another person smoking in the household.

Incidence of asthma (estimated)

Of the 624 adult subjects who provided data on the duration of their asthma, 47 (7.5%) reported having received a diagnosis within the previous twelve months. By extrapolation to all patients fulfilling criteria for asthma in the screening questionnaire, annual incidence rates for asthma were estimated to be 46 [95% CI: 33–59] cases/10 000 for Algeria, 43 [30–55] cases/10 000 for Morocco and 28 [18–39] cases/10 000 for Tunisia.

Characteristics of subjects with asthma

The characteristics of the adult subjects with asthma identified in the survey who completed the asthma questionnaire are presented in Table 2. The equivalent information for the paediatric population is provided in an accompanying paper [30]. The mean age of the subjects with asthma ranged from 36.5 years in Morocco to 44.3 years in Tunisia. Women were over-represented compared to men by a factor of around 1.5. Exposure to tobacco smoke was higher in Tunisia than in the other two countries. Overall, 38.7% of subjects stated that they were in good, very good or excellent health. The most frequently cited treated comorbidities were arterial hypertension (85 subjects; 13.6%) and diabetes (42 subjects; 6.7%).

Asthma features

Asthma history is presented in Table 3. The time since diagnosis of asthma was very variable, and was over ten years for most subjects. The initial presenting symptoms were breathlessness (39.9% of subjects, particularly in Tunisia) and chest tightness (35.5%, particularly in Algeria and Morocco). The diagnosis was made as often by a general practitioner as by a specialist, except in Morocco, where it was made by a specialist in two-thirds of cases. It should be noted that 41 patients overall (6.8%) were diagnosed during a visit to the emergency department of a hospital. The majority of subjects considered their asthma to have improved since diagnosis, although 336 overall (54.7%) had experienced a severe attack in the previous year.

Impact of asthma

A series of questions collected information on the impact of asthma attacks on subjects' lives in the previous year. Around three-quarters of subjects overall (74.3%) reported being handicapped by their asthma all or most of the time (Fig. 4). Around one-quarter of respondents reported at least one visit to a hospital emergency department in the previous year and a similar proportion reported at least one day's absence from work or school due to asthma (Table 4). The proportion of subjects who reported being very or quite limited by their asthma with respect to sport and leisure, normal physical activity, professional activities, social activities, lifestyle and household tasks ranged between one-third and one-half, according to the item (Table 4). In addition, 48.0% reported that their sleep was very or quite disturbed by asthma.

Discussion

The overall prevalence of asthma in the general population of the Maghreb countries participating in this survey was estimated to be 3.6%, with no relevant difference apparent between the three countries. This corresponds to

Table 3. Asthma history

	Algeria (N = 154)	Morocco (N = 236)	Tunisia (N = 234)
Time since diagnosis			
Mean±SD	14.1±11.9	14.5±11.9	13.8±13.4
Median [Range]	11 [0–60]	13 [0–72]	10 [0–70]
Diagnosis provided by:			
General practitioner	64 (42.7%)	59 (26.1%)	96 (41.6%)
Specialist	62 (41.3%)	143 (63.3%)	114 (49.4%)
Emergency room	10 (6.7%)	19 (8.4%)	12 (5.2%)
Presenting symptoms*			
Breathlessness	49 (31.8%)	85 (37.1%)	196 (84.9%)
Chest tightness	75 (48.7%)	145 (63.3%)	85 (36.8%)
Persistent cough	57 (37.0%)	122 (53.3%)	92 (39.9%)
Cold stress dyspnoea	61 (39.6%)	121 (52.8%)	64 (27.7%)
Wheezing	34 (22.1%)	87 (38.0%)	70 (30.3%)
Seasonality	89 (58.2%)	152 (66.7%)	156 (67.5%)
Evolution since diagnosis			
Improvement	74 (48.4%)	163 (71.2%)	138 (59.5%)
No change	52 (34%)	43 (18.8%)	66 (28.4%)
Deterioration	27 (17.6%)	23 (10%)	28 (12.1%)
Severe attack in past year	105 (68.6%)	123 (53.7%)	108 (46.6%)

*Replies are not mutually exclusive; only replies cited by >15% of respondents overall are reported. A severe attack was defined as a severe bout of coughing, breathlessness, chest tightness or wheezing.

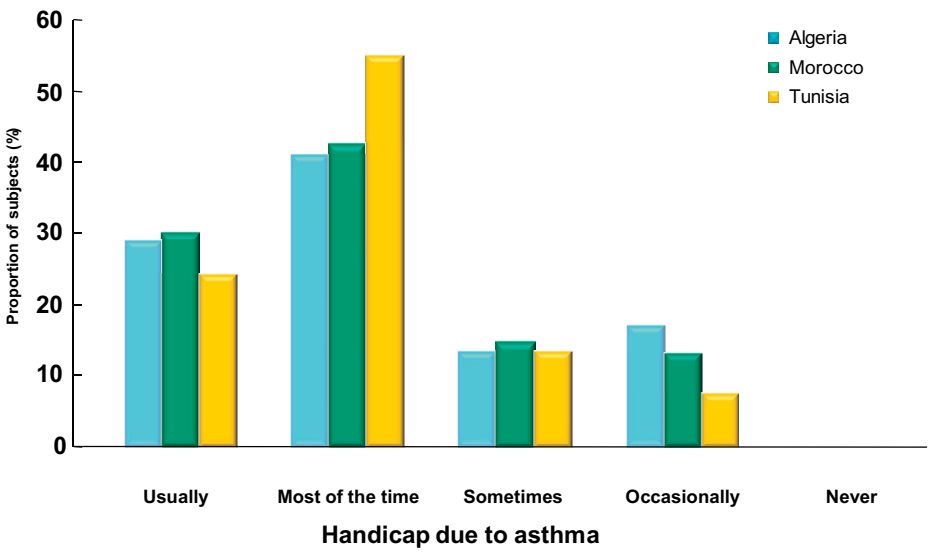

Fig. 4. Handicap due to asthma. Data are presented as the percentage of respondents. No respondent in any country replied 'Never'.

a moderate prevalence rate from a worldwide perspective, consistent with the rating of these countries in the most recent GINA burden of asthma report [1]. However, the large scale of the AIRMAG project, its nationwide scope and its use of the AIR methodology, previously used in reference studies of the epidemiology of asthma in other countries, strongly increases the confidence with which such a rating can be assigned.

Countrywide prevalence rates for paediatric asthma in the three Maghreb countries ranged from 3.54% to 4.41%. These are lower than the most recent single-centre prevalence estimates determined in the 1990s [22]. This difference may be due, at least in part, to the fact that the latter studies were all performed in relatively urbanised areas. A higher prevalence of asthma in urban areas compared to rural areas was observed for children in the ISAAC III study [31], and also in the AIRMAG study, at least for the overall population. Concerning adults, the prevalence rates observed are higher than those observed in previous studies in Algeria, although it should be pointed out that the latter are relatively old, did not cover the whole country and, in some cases, did not use representative sampling methods [24]. In general, prevalence rates for asthma in both children and adults

Table 4. Asthma impact

	Algeria (N = 154)	Morocco (N = 236)	Tunisia (N = 234)
Hospitalisations			
At least one	21 (13.7%)	20 (8.7%)	33 (14.2%)
Mean number±SD*	6.8±10.2	3.2±4.2	5.7±6.7
Emergency room visits			
At least one	58 (37.9%)	48 (21.0%)	59 (25.4%)
Mean number±SD*	6.3±9.8	3.2±3.9	3.8±5.3
Family doctor call-outs			
At least one	132 (93.0%)	171 (85.9%)	183 (80.3%)
Mean number±SD*	6.5±10.4	3.2±3.3	3.9±6.0
Absenteeism			
At least one	34 (22.2%)	69 (30.3%)	46 (19.8%)
Mean number±SD*	19.6±22.9	10.3±13.6	13.8±21.4
Causes limitations in†:			
Sport and leisure	*N* = 60 30 (50.0%)	*N* = 167 78 (46.7%)	*N* = 93 43 (46.2%)
Normal physical activity	*N* = 66 27 (40.9%)	*N* = 175 81 (46.3%)	*N* = 154 70 (45.5%)
Professional activities	*N* = 62 22 (35.5%)	*N* = 113 58 (51.3%)	*N* = 97 32 (33.0%)
Social activities	*N* = 69 25 (36.2%)	*N* = 134 52 (38.8%)	*N* = 109 37 (33.9%)
Sleep	*N* = 142 68 (47.9%)	*N* = 203 81 (39.9%)	*N* = 226 125 (55.3%)
Lifestyle	*N* = 142 50 (35.2%)	*N* = 171 67 (39.2%)	*N* = 222 108 (48.6%)
Household tasks	*N* = 123 54 (43.9%)	*N* = 130 63 (48.5%)	*N* = 151 85 (56.3%)

*Calculated for subjects with at least one event.

†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.

were quite similar across the three Maghreb countries, probably reflecting similar exposure to environmental and lifestyle risk factors.

As in the ECRHS [32] and ISAAC [4], we observed a higher prevalence of asthma in female subjects then in males. However, this difference was not consistent between countries, being greatest in Morocco but not observable in Algeria. The pattern of age-specific prevalence rates exhibited a U-shaped curve, with highest rates in children and the >54 year age group. However, these age differences were more marked in Algeria than in Morocco. For both age and gender, the pattern observed in Tunisia was intermediate between those observed in Algeria and Morocco. Since asthma prevalence before puberty is higher in boys than in girls, whereas the reverse is true in adults [33], these differences could arise from differences in the age pyramids between the three countries.

Important regional variations in asthma prevalence were observed in all countries. Generally speaking, prevalence was highest in the more urbanised coastal plains than in the more sparsely-populated mountainous and desert regions. An exception to this trend was the unexpectedly high prevalence rate observed in the Southern desert part of Morocco. However, it should be noted that confidence intervals for the prevalence rate were wide in this region, due to the low number of respondents (257 subjects overall, 15 with asthma). These findings are consistent with previous observations on the prevalence of asthma in Africa [34], and may reflect an increased risk of asthma associated with urbanisation [20].

Annual incidence rates for asthma ranged between 28 and 46 cases per 10,000 subjects. It should be noted that these overall incidence rates may conceal marked differences in incidence related to age and gender, as has previously been reported in the ECRH survey [32]. Given the relatively low number of incident cases in our sample, this level of detail is not feasible in the AIRMAG population. The incidence of asthma appeared somewhat lower in Tunisia than in the other two countries, which may reflect the lower relative weight of children in the population structure of this country.

From a functional standpoint, most subjects reported that their asthma had a significant impact on their lives. Around three-quarters of subjects reported asthma-related handicap all or most of the time, around half had visited an emergency department due to asthma in the previous year and around one quarter had been hospitalised or needed time off work or school. These findings suggest that asthma is poorly controlled in the Maghreb countries. The findings of the AIRMAG survey with respect to asthma control, management and treatment will be developed in another article of this supplement [35].

This study has several strengths and limitations. The large sample size and the nationwide sampling are clear strengths of the study, as is the relatively high response rate (65% globally and reaching 75% in Tunisia) compared to random population-based studies in Europe. The use of the AIR survey methodology is another strength of the study, since this has now been used widely and been validated in many parts of the world, which will allow the results of the AIRMAG study to be compared with data collected elsewhere.

With respect to limitations, the method of data collection by questionnaire-based interviews in the home, limits the precision of the medical data collected, notably with respect to diagnosis, medication use and healthcare resource consumption. Clearly, case ascertainment is not possible in this type of general population study. Nonetheless, over 95% of respondents reported having received a diagnosis of asthma from a physician. Secondly, the relatively low participation rate in Algeria (63%) is of concern, although the consistency of the prevalence results between the three countries would argue against any major bias being introduced hereby. Overall response rates are not inconsistent with those generally reported in general population surveys in Europe and North America. The fact that the survey was performed around the time of elections in Algeria may have influenced the participation rate. Thirdly, there may be a sampling bias due to incomplete telephone coverage, with certain groups, for example older people or those in very rural areas, not having telephones. Fixed telephone coverage ranges from 51% of households in Morocco to 57% in Algeria, and the proportion of individuals with mobile telephones ranges from 64% in Morocco to 81% in Algeria. Finally, it is possible that individuals with health problems may have been more motivated to participate in the survey, which could lead to an overestimate of prevalence rates.

In conclusion, the AIRMAG survey has shown that the prevalence of asthma in the Maghreb countries is moderate, but its impact is high.

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.

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