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A relatively high prevalence and severity of asthma, allergic rhinitis and atopic eczema in schoolchildren in the Sultanate of Oman

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Objectives: Although asthma, allergic rhinitis and eczema are among the most common chronic diseases in children worldwide, there is very limited information about the burden of these conditions in Oman. The aim of this study was to determine the prevalence and severity of symptoms of asthma, allergic rhinitis and eczema in Omani schoolchildren using the International Study of Asthma and Allergies in Childhood (ISAAC) Phase I questionnaire.

Methods: An Arabic version of the ISAAC Phase I questionnaire was completed by parents of 3893 children aged 6–7 years and self-completed by 3174 children aged 13–14 years, randomly selected from a nationwide sample of public schools.

Results: The prevalence rates of reported diagnoses of asthma, allergic rhinitis and eczema were higher in older children (20.7%, 10.5% and 14.4% compared with 10.5%, 7.4% and 7.5%, respectively, in young children). In young children, 277 were current wheezers and of these 40.8% had sleep-disturbing wheeze at least once a week and 45.1% had speech-limiting wheeze during the past year. Similarly, 283 older children were current wheezers, and of these 30.0% had sleep-disturbing wheeze at least once a week and 37.5% had speech-limiting wheeze during the past year. Exercise-induced wheeze was higher in older children (19.2% *vs* 6.9%; $P < 0.001$). Allergic rhinitis and eczema were also associated with significant sleep disturbance and limitation of activity in both age groups.

Conclusion: Allergic conditions in Omani schoolchildren are common and associated with significant morbidity. Further research is required to identify the local risk factors for allergy to allow better understanding and management of these conditions.

Key words: allergic rhinitis, asthma, eczema, International Study of Asthma and Allergies in Childhood, Oman, prevalence.

INTRODUCTION

The health and economic impact of childhood asthma, allergic rhinitis and atopic eczema is considerable and there is worldwide concern about the

increasing prevalence of these conditions.¹ The results of population-based prevalence studies are influenced by many factors including differences in disease definition and classification, diagnostic methods, sampling methodology and public awareness of the condition under evaluation.² Although data from many different countries provide compelling evidence that asthma and other allergic diseases are increasing, these were primarily from developed countries and may not be representative of the rest of the world.^{2–4}

The International Study of Asthma and Allergies in Childhood (ISAAC) has established standardized methods (validated written and video questionnaires) to measure and compare prevalence rates and sever-

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ity of allergic conditions in children all over the world and to explore the possible causes and risk factors for these conditions.⁵ As a participating centre in ISAAC Phase I, we conducted a nationwide study providing the only available data on the prevalence of asthma, allergic rhinitis and atopic eczema in the Sultanate of Oman. The summary of the results from our centre has been published as part of the ISAAC Steering Committee publications.⁶⁻⁹ Analysis of the ISAAC worldwide summary data indicates that the prevalence rates of symptoms of allergic conditions for Omani children aged 6–7 years are in the low to intermediate range. However, an alarming finding was that Oman ranked among the top countries in the global ranking of symptoms taken to indicate severe asthma.⁶ For example, the prevalence of waking one or more nights per week in the past 12 months was 3.5% (nearly 50% of all wheezers), putting Oman in the top five countries for this severe symptom (Brazil, UK, Costa Rica, Chile and Oman).⁶ Similarly, the 13–14-year-old group ranked among the top for the prevalence of severe asthma symptoms such as sleep-disturbing wheeze and speech-limiting wheeze.⁶

The Sultanate of Oman occupies the southeastern corner of the Arabian Peninsula and is located between latitudes 16°40' and 26°20' north and longitudes 51°50' and 59°40' east. It has a total land area of 310 000 km². The land has a variety of topographical features consisting of coastal plains, mountains, valleys and deserts with the coastal areas being the most densely populated. The climate differs from one area to another; it is hot and humid in the Northern coastal areas in summer while it is hot and dry in the interior. The south has a moderate climate and regular monsoon rains in summer. The Omani population is approximately two million with 49% under 15 years of age and only 4.5% above 65 years. The government provides free health care to all citizens through a network of primary (health centres and local hospitals), secondary (regional hospitals) and tertiary (referral hospital) health institutions.

The aim of the present study was to provide a detailed analysis of the prevalence and severity of self-reported symptoms and diagnoses of asthma, allergic rhinitis and atopic eczema in 6–7 and 13–14-year-old children making comparisons between males and females, between 6–7 years olds and 13–14 years olds, and assessing the extent of underdiagnosis of asthma, and to compare the prevalence of severe and frequent symptoms of asthma with those observed in other countries.

METHODS

Subjects and sampling

The study was designed to determine the prevalence of allergic conditions in native Omani children. Therefore a nationwide sample of public schools, where more than 99% of children are Omani natives, was chosen for conducting the study using a stratified multistage sampling method, using the 10 health

regions of Oman as strata. The sample frame of the survey was a list of public schools provided by the Ministry of Education indicating the district and town, number of schools and the numbers of children in primary grades I and II for the 6–7 years age group and preparatory grades I and II for the 13–14 years age group. The first stage of sampling consisted of randomly selecting schools as primary sample units from each health region. In the second stage, one class was chosen randomly from each school as the secondary sample unit with participation of all children in the selected class. The total national target sample was distributed among the 10 regions of the country using the proportion allocation method. In order to achieve a final total sample size of approximately 6000 children (3000 in each age group), a total of 7625 questionnaires were distributed (4079 to children aged 6–7 years and 3546 to children aged 13–14 years). The sample size for the 6–7-year-old age group was higher by 15% to allow for the expected lower response rate of the parents in this group. A total of 220 schools participated (118 primary and 102 preparatory). Of these, 117 (53%) were male schools (66 primary and 51 preparatory).

ISAAC Phase I written questionnaire

The ISAAC standardized written questionnaire was used to identify symptoms of asthma, allergic rhinitis and atopic eczema.⁵ The study design and data quality assurance followed the ISAAC protocol in all aspects, including the double entry of data and translation guidelines.³ The English version was translated into Arabic by one translator and this was translated back into English by another translator. The original English and back translation versions were reviewed and any differences between them were resolved. The questionnaires were completed by parents of the 6–7-year-olds and self-completed by the 13–14-year-olds.

Data collection and analysis

Data were collected and entered according to the ISAAC protocol⁶ and were analysed using the SPSS package for Windows version 9.0 (SPSS Inc., Chicago, IL, USA). Prevalence rates were calculated by dividing the number of positive responses to each question by the number of completed questionnaires. Comparisons between the two age groups were performed using the χ^2 test. A *P*-value of < 0.05 was considered statistically significant. In the data comparing the prevalence of severe asthma symptoms in Oman with other countries, ratios of the prevalence of each severe symptom to the prevalence of wheeze during the past 12 months (e.g. prevalence of sleep-disturbing wheeze divided by prevalence of wheeze) were used as indexes of the proportion of wheezers with these severe symptoms.

Ethical approval of the study protocol was obtained from both the Ministry of Health and the Ministry of Education.

RESULTS

Responses to questionnaire

The ISAAC questionnaire was completed by a total of 7067 pupils (92.7% response rate) in the two age groups from the 10 health regions: 3893 pupils aged 6–7 years (95.4% response rate) and 3174 pupils aged 13–14 years (89.5% response rate).

Table 1 shows the prevalence rates of reported symptoms and diagnoses of asthma, allergic rhinitis (hay fever) and eczema by age group and gender. The cumulative prevalence of wheeze (wheeze ever), and the 12-month prevalence of any wheeze, and exercise wheeze were significantly higher in the 13–14 years age group (15.6%, 8.9%, and 19.2%, respectively), compared with the 6–7 years age group (13.8%, 7.8% and 6.9%, respectively). There was no significant difference between the two groups in the 12-month prevalence of severe asthma symptoms (four or more wheezing attacks, sleep-disturbing wheeze, or speech-limiting wheeze). In the 13–14 years age group, exercise-induced wheeze was more frequent than 'any wheeze' (19.2% *vs* 8.9%, $P < 0.001$). Night cough not related to upper respiratory tract infection was equally frequent in both age groups (19.6% and 20.9% in young and older children, respectively). The cumulative (ever had) prevalence rates of reported diagnoses of asthma, allergic rhinitis and eczema were higher in the older group (20.7%, 10.5% and 14.4% compared to 10.5%, 7.4% and 7.5%, respectively, in young children, $P < 0.01$). Symptoms of aller-

gic rhinitis were more frequent in the older group. The 12-month prevalence of rash with atopic distribution was similar in both age groups (5.8% and 5.2% in young and old children, respectively).

In the 6–7 years age group, the cumulative prevalence of wheeze, the 12-month prevalence of wheeze, exercise-induced wheeze, and parent-reported asthma diagnosis were significantly higher in males. In contrast, there was no significant difference between the two sexes in asthma diagnosis or any of its symptoms in the 13–14 years age group, except for exercise-induced wheeze which was more common in males (21.5% *vs* 16.7%, $P < 0.001$). In both age groups, there was no significant gender difference in the prevalence of night cough or symptoms of severe asthma (four or more attacks per week, wheeze that disturbs sleep and speech-limiting wheeze). The cumulative and 12-month prevalence rates of symptoms of allergic rhinitis were more common among males of both age groups, but there was no significant gender difference in the prevalence of chronic rash in either of the two age groups.

Table 2 shows the prevalence rates of symptoms of severe asthma in children reporting wheeze in the previous 12 months. The prevalence rates of severe asthma symptoms in these wheezy children were high. Of the 277 wheezy young children, 29.6% (17% plus 12.6%) had four or more wheezing episodes, 40.8% had sleep-disturbing wheeze at least one night per week, 45.1% had speech-limiting wheeze and 50.1% had exercise-induced wheeze in the past 12 months. Similarly, of the 283 wheezy adolescents,

Table 1 The estimated prevalence (%) of self-reported symptoms and diagnoses of asthma, allergic rhinitis and atopic eczema in Omani schoolchildren by age group and gender

Symptoms	6–7 year age group (<i>n</i> = 3893)				13–14 year age group (<i>n</i> = 3174)			
	Total sample	Male (<i>n</i> = 1624)	Female (<i>n</i> = 1550)	<i>P</i> -value	Total sample	Male	Female	<i>P</i> -value
Ever experienced wheeze*	13.8	15.8	11.3	< 0.001	15.6	16.3	14.9	0.28
12-month prevalence of:								
Any wheeze*	7.1	8.5	5.3	< 0.001	8.9	9.2	8.6	0.59
Four or more wheezing episodes	2.5	3.0	2.0	0.06	2.6	3.0	2.3	0.18
One or more nights per week disturbed	3.5	4.0	2.8	0.06	2.9	3.2	2.6	0.29
Speech-limiting wheeze	3.2	3.4	3.0	0.54	4.0	4.2	3.7	0.51
Exercise-induced wheeze*	6.9	7.7	6.0	0.4	19.2	21.5	16.7	< 0.001
Night cough in absence of cold	19.6	20.3	18.7	0.21	20.9	21.3	20.4	0.56
Ever had asthma*	10.5	12.4	8.0	< 0.001	20.7	21.4	20.0	0.35
Ever had rhinitis symptoms	22.0	23.2	20.4	0.03	34.6	37.9	31.0	< 0.001
12-months prevalence of:								
Rhinitis symptoms*	15.0	16.2	13.5	0.02	23.8	25.5	22.1	0.02
Rhinitis with itchy eyes*	7.2	7.7	6.5	0.14	13.4	14.5	12.1	0.04
Activity limited*	13.3	13.7	12.6	0.15	22.2	24.3	19.9	< 0.01
Ever had hay fever*	7.5	8.6	6.0	0.002	10.5	10.8	10.1	0.56
Ever had chronic rash*	10.2	10.3	10.2	0.91	12.6	13.4	11.7	0.15
12-month prevalence of:								
Rash with atopic distribution	5.8	6.2	5.2	0.19	5.2	5.2	5.2	0.81
One or more nights per week disturbed	1.7	1.7	1.8	0.43	1.9	2.2	1.5	0.24
Ever had eczema*	7.4	6.8	8.0	0.15	14.4	14.2	14.6	0.76

p value: for comparisons between male and female within each age group.

* Denotes statistically significant difference between the two age groups ($P < 0.05$).

27.2% had four or more wheezing episodes, 30.0% had sleep-disturbing wheeze at least one night per week, 37.5% had speech-limiting wheeze and 69.3% had exercise-induced wheeze in the past 12 months.

Table 3 shows the proportion of children with wheeze in the preceding 12 months who reported frequent or severe asthma symptoms. In both age groups, many children who reported asthma symptoms did not report themselves as ever having had asthma. Only 43.8% of young children and 52.1% of adolescents with any past history of wheeze responded positively to 'ever had asthma'. Similarly, only 53.8% of young and 60.4% of older children with positive histories of wheeze during the past year reported histories of asthma. Even among those with symptoms of severe asthma (four or more wheezing episodes, sleep-disturbing wheeze and speech-limiting wheeze) a large number in both age groups did not report a diagnosis of asthma. Three of 22 young children (13.6%) and 11 of 44 older children (25%) who reported a symptom combination of sleep-disturbing wheeze, speech-limiting wheeze and exercise-induced wheeze did not report any

history of asthma. Although dry night cough in absence of cold during the past 12 months was the most frequent symptom in both age groups, only 30.2% of young and 40.1% of older children reported an asthma diagnosis.

Table 4 shows the prevalence of severe and frequent asthma symptoms in Omani schoolchildren compared with those of other ISAAC participating countries from the Eastern Mediterranean region in addition to Australia and the UK. For 6–7-year-old children, the ratios of children with sleep-disturbing wheeze and speech-limiting wheeze in Oman were higher than those of any of the listed countries. This was due to the relatively high prevalence of severe symptoms compared to the prevalence of 'any wheezing' in Omani children. The prevalence of sleep-disturbing wheeze in Oman was nearly four times that of Iran (3.5% *vs* 0.9%) and more than double that of Malta (3.5% *vs* 1.5%). It was even higher than that of Australia (3.5% *vs* 2.8%), a country with the highest prevalence rate of wheeze among all ISAAC participating countries, being more than three times that of Oman. For the 13–14 years age group, the ratios of the prevalence rates of sleep-disturbing wheeze to the prevalence rates of wheeze in Arab countries (Oman, Kuwait, Lebanon and Morocco) were higher than those of non-Arab countries (Iran, Pakistan, Malta and UK). Among these, the three Asian Arab countries (Oman, Kuwait and Lebanon) had the highest prevalence rates of sleep-disturbing wheeze. Similarly, these three Arab countries had the highest prevalence rates of speech-limiting wheeze in the Eastern Mediterranean region. In the UK, a country with the highest worldwide prevalence of wheeze in the last 12 months (32.2%), the ratios of the prevalence rates of sleep-disturbing wheeze and speech-limiting wheeze were relatively small (0.11 and 0.26, respectively). The corresponding ratios in Oman were 0.33 and 0.45.

Table 2 Proportion of children with wheeze in the preceding 12 months who reported frequent or severe asthma symptoms (277 children aged 6–7 years and 283 children aged 13–14 years)

Symptoms	6–7 year No. (%)	13–14 year No. (%)
Wheezing episodes in the past year		
1–3	151 (55.0)	184 (65.0)
4–12	47 (17.0)	40 (14.1)
More than 12	35 (12.6)	37 (13.1)
Sleep disturbance due to wheezing		
No sleep disturbance	71 (25.6)	63 (22.3)
Less than one night per week	93 (33.6)	135 (47.7)
One night or more per week	113 (40.8)	85 (30.0)
Speech-limiting wheeze in the past year	125 (45.1)	106 (37.5)
Exercise-induced wheeze in the past year	141 (50.1)	196 (69.3)

DISCUSSION

Our participation in ISAAC Phase I yielded the first epidemiological survey of symptoms of asthma and other allergies in Oman. The summary of our centre's

Table 3 The frequency of parent-reported (for 6–7 year age group) and self-reported (for 13–14 year age group) asthma diagnosis 'ever had asthma' within each group of children reporting the presence each asthma symptom

Symptoms	6–7 years		13–14 years	
	No. with positive response	Reported asthma <i>n</i> (%)	No. with positive response	Reported asthma <i>n</i> (%)
Ever experienced wheeze	539	236 (43.8)	495	258 (52.1)
12-months experience of:				
Any wheeze	277	149 (53.8)	283	171 (60.4)
Four or more wheezing episodes	99	51 (51.2)	84	56 (66.7)
One or more nights disturbed per week	135	66 (48.9)	92	67 (72.8)
Speech-limiting wheeze	125	85 (68.0)	126	82 (65.1)
Exercise-induced wheeze	270	170 (63.0)	608	297 (48.8)
Subjects reporting all the three above	22	19 (86.4)	44	33 (75.0)
Night cough in absence of cold	764	231 (30.2)	662	243 (40.1)

Table 4 Proportions of wheezing children with symptoms of severe wheeze (sleep-disturbing and speech-limiting) in the Eastern Mediterranean participating countries, in addition to Australia and the UK.[#] A comparison from ISAAC Phase I global results*

	12-month prevalence of wheeze (%)	Sleep-disturbing wheeze Prevalence (%)	Ratio**	Speech-limiting wheeze Prevalence (%)	Ratio**
6–7 year age group					
Oman	7.1	3.5	0.49	3.2	0.45
Iran	5.4	0.9	0.17	0.9	0.17
Malta	8.8	1.5	0.17	1.2	0.14
Australia	24.6	2.8	0.11	3.9	0.16
13–14 year age group					
Oman	8.9	2.9	0.33	4.0	0.45
Kuwait	17.0	5.7	0.34	10.9	0.62
Lebanon	14.4	5.0	0.35	7.0	0.49
Morocco	7.5	2.2	0.29	2.7	0.36
Iran	10.9	1.8	0.17	2.6	0.24
Pakistan	8.5	1.6	0.19	3.9	0.46
Malta	16.0	2.4	0.15	3.6	0.23
UK	32.2	3.5	0.11	8.5	0.26

[#] Australia and UK were selected in addition to the regional countries as reference to countries with highest 12-month prevalence of wheezing in each age group.

* Reference 6.

** Ratios were calculated by dividing the 12-month prevalence of severe wheeze by the prevalence of wheeze within the same period.

results has been published as part of the ISAAC Steering Committee publications.^{6–9} The present study presents a detailed analysis of the data from schoolchildren in Oman with some regional comparisons, highlighting three important findings. First, the prevalence rates of symptoms of asthma, allergic rhinitis and atopic eczema in Omani schoolchildren were higher than those of many neighbouring countries. Second, these conditions were associated with significant morbidity as assessed by symptoms of severe asthma and limitation of activities. Finally, many children with relatively specific symptoms of asthma (sleep-disturbing wheeze and speech-limiting wheeze) did not report any history of asthma diagnosis, suggesting underdiagnosis of asthma in these children.

For the 6–7 years age group, the estimated national prevalence rate of parent-reported asthma diagnosis ('ever had asthma') was 10.5%. This puts Oman in the intermediate prevalence category when compared with the rest of the world.⁶ Only three Eastern Mediterranean countries (Iran, Malta and Oman) included this ISAAC Phase I optional age group in their surveys with a mean regional prevalence rate for parent-reported asthma diagnosis of 6.5%. Among these, Oman had the highest prevalence rates of 'ever had asthma', any past history of wheeze and past 12-month history of any wheeze, speech-limiting wheeze, sleep-disturbing wheeze and night cough.⁶ In keeping with findings in most ISAAC centres, males in this age group had significantly higher prevalence rates of cumulative wheeze, 12-month history of any wheeze, exercise-induced wheeze, and parent-reported diagnoses of asthma than females.⁶ How-

ever, there was no significant difference between the two sexes in night cough or any of the symptoms suggestive of severe or uncontrolled asthma (the 12-month prevalence of four or more attacks of wheeze, sleep-disturbing wheeze and speech-limiting wheeze). Symptoms of allergic rhinitis in Omani schoolchildren of this age group were also common with 'ever had chronic nose problem with sneezing or blocked nose in the absence of cold and flu' being reported in 22% of children. The prevalence rate of current symptoms of allergic rhinoconjunctivitis (past 12-month history of symptoms of allergic rhinitis and itchy-watery eyes) of 7.2% puts Oman in the intermediate prevalence band (5–10%) for this condition.^{7,8} The prevalence figures for allergic rhinitis and its morbidity (limitation of activity) in Oman are much higher (two- to threefold) than those of Iran, the geographically nearest participating country to Oman in this age group.^{7,8} Similarly, the prevalence rates of parent-reported diagnosis and symptoms of atopic eczema in Oman were significantly higher than those in Iran.⁹

Like most participating countries, the prevalence rates of self-reported symptoms of asthma, allergic rhinitis and eczema in the 13–14 years age group were higher than those of the younger group.^{6,7} The prevalence rate of self-reported asthma diagnosis in the 13–14 years age group in Oman (20.7%) was the highest among the seven Eastern Mediterranean participating countries: Iran (2.7%), Kuwait (17.5%), Lebanon (11.6%), Malta (11.1%), Morocco (11.7%) and Pakistan (7.3%).⁶ Only five of the 56 ISAAC participating countries with data for this age group had prevalence rates of self-reported asthma diagnosis higher than Oman

(Peru, UK, Australia, New Zealand and Singapore).⁶ In all of them and in many other countries the prevalence rate of 12-month prevalence of wheeze was higher than the prevalence rate of self-reported asthma diagnosis ('ever had asthma'). In contrast, Oman was one of the few countries where the prevalence rate of 'ever had asthma' was significantly higher (20.7%) than the 12-month period prevalence of 'any wheeze' (8.9%).⁶ The cause of this atypical pattern is not clear. One possible cause is that asthma diagnosis was over-reported by children in some countries, including Oman. A second possibility is that some children with a previous history of asthma ('ever had asthma') in this age group did not have any wheeze during the last 12 months. An alternative and more plausible explanation is that the diagnosis of asthma may be based on symptoms other than 'ordinary' wheeze. The latter is supported by the relatively high prevalence rate of night cough (20.9%) and exercise-induced wheeze (19.2%) in our children.

In 13–14-year-old children, the prevalence rate of exercise-induced wheeze was much higher than the prevalence of 'any wheeze' (19.2% *vs* 8.9%). This pattern was also reported in most participating (50 of 56) countries.⁶ On theoretical grounds, one would expect the opposite pattern (i.e. the reporting of 'any wheeze' to be more frequent than any of its categories such as exercise-induced wheeze). This unexpected pattern has not been previously explained. One possible explanation is that children in this age group, who self-completed the ISAAC questionnaire, perceived exercise-induced wheeze as a separate entity from the ordinary wheeze of asthma. Alternatively, it may be due to their misunderstanding of the questionnaire resulting in the reporting of normal exhaustion and hyperventilation after exercise as exercise-induced wheeze.

Our results also showed that asthma, allergic rhinitis and atopic eczema were associated with significant morbidity as shown by the high proportion of children with symptoms that indicate severe or uncontrolled asthma (e.g. sleep-disturbing wheeze and speech-limiting wheeze), and by the high prevalence of sleep disturbance and limitation of activities due to symptoms of allergic rhinitis and eczema in both age groups. For the 6–7 years age group, Oman ranked fifth out of 38 countries in ISAAC global ranking for the prevalence rate of sleep-disturbing wheeze and eighth for the prevalence rate of speech-limiting wheeze.⁶ Among the three Eastern Mediterranean participating countries with data for this age group, Oman had the highest proportion of wheezers with severe asthma symptoms (sleep-disturbing and speech-limiting wheeze).⁶

For the 13–14 years age group, Oman ranked 14 out of 56 countries in ISAAC global ranking for the prevalence rate of sleep-disturbing wheeze.⁶ Among the seven Eastern Mediterranean participating countries with data from this age group, Oman ranked third for the prevalence rates of both sleep-disturbing wheeze and speech-limiting wheeze, preceded only by Kuwait and Lebanon, which were also the top two countries in the global ranking for the prevalence rate of sleep-disturbing wheeze.^{6,10–12} Although the preva-

lence rates of self-reported asthma symptoms and diagnosis have been studied in other Arab Gulf States, there is little scope for comparisons between Oman and these countries because of the difference in the age groups studied, times of studies and methodology.^{13–16} Questionnaire-based studies of schoolchildren aged 7–12 years in different cities of Saudi Arabia showed prevalence rates of self-reported asthma diagnosis of 4–10%, wheeze of 12–16%, allergic rhinitis of 12–24%, and eczema of 7–15%.^{13–15} In a recent study from the United Arab Emirates that used the ISAAC questionnaire, the prevalence rates of asthma diagnosis, wheezing and nocturnal cough in 6–13-year-old children were 13%, 15.6% and 21%, respectively.

In the analysis of questionnaire-based results, one should consider several factors. A person's response to a given questionnaire depends on a number of psychological, social, and cultural characteristics including public awareness, healthcare practice, language and interpretation of the questions.¹⁷ While the diagnostic significance of mild wheeze may be questioned, the occurrence of frequent severe speech-limiting wheeze and sleep-disturbing wheeze is widely accepted as clinically important and suggestive of uncontrolled asthma.⁶ The possible causes of the relatively high prevalence rates of symptoms indicative of severe or uncontrolled asthma (sleep-disturbing wheeze, speech-limiting wheeze and frequent attacks of wheeze) need to be explored. Unfortunately, there are no previous data on asthma and other allergic conditions in Oman to allow direct evaluation of potential risk factors for these diseases. With the data available at this stage, we can only postulate some possible explanations for these results. Confounding methodological factors include over- and under-reporting, problems with the interpretation of questionnaires and sampling bias.¹⁷ Although the consistency of reporting across all the atopic symptoms in all ISAAC centres suggests that regional differences in allergic symptoms are likely to be real,^{6–9} variations in the interpretation of the questionnaire remain a real problem due to cultural and language differences.¹⁷ The ISAAC video questionnaire was developed to reduce problems with the translation of the written questionnaire and has been validated against bronchial hyperresponsiveness in English speaking communities.¹⁸ Our centre did not include the video questionnaire, but in Kuwait, a country with the same language and similar culture, there was poor agreement between the written and video questionnaires.¹² One possible reason for the observed high prevalence of severe symptoms is under-reporting of mild asthma symptoms such as 'any wheeze'. This would make the majority of wheezers (positive responders) appear to be suffering from severe symptoms. Another potential factor is related to public awareness and healthcare practice. Under-recognition and under-diagnosis can lead to under-treatment and therefore more severe symptoms in the affected children. This possibility is supported by the finding that many of our children with various asthma symptoms responded negatively to the question of 'ever had asthma'. Approximately

30–50% of children aged 6–7 years and 25–35% of children aged 13–14 years with any of the symptoms taken to reflect severe asthma were not reported to have had any history of asthma. In addition, there are a number of real risk factors for the development of asthma and other allergies that need to be considered. These include genetic predisposition, consanguinity, young maternal age at the time of birth, low maternal education and low birth weight, and environmental factors such as aeroallergens, diet and 'Westernized' lifestyle.^{19–21}

Like other Gulf States, the Sultanate of Oman has experienced major developments in the last three decades with substantial changes in lifestyle and a shift towards 'Westernization', paralleled by major changes in the profile of health problems with chronic non-communicable diseases such as diabetes mellitus, coronary heart disease and asthma emerging as major health issues in the country. The similarity in the prevalence patterns of allergic symptoms in Oman and Kuwait is worth exploring.^{6,12} Oman and Kuwait were the only ISAAC centres from the Arab Gulf States. The two countries have many things in common. They have the same language, similar culture, climate and diet and, perhaps more importantly, they have both undergone substantial development in the last three decades. The similarities in the prevalence patterns of symptoms of allergy suggest similar causes in the two countries for the apparently high prevalence of severe allergic symptoms in their schoolchildren. Studies from Kuwait have shown a high prevalence of atopy and allergic sensitization to airborne allergens among asthmatics and healthy blood donors.^{12,20–22} It has been suggested that the high prevalence of sensitization in Kuwait was mainly due to the planting and cultivation of foreign trees in urban areas.^{12,21} Because of the similar practice, the same process may be important in Oman. In a recent study on the influence of consanguinity and IgE receptor genotypes on the clinical manifestations of asthma in Kuwaiti children, the rate of consanguinity was 54% in the general population and 42% among families of asthmatic children.²³ In addition, children homozygous for the abnormal IgE receptor (Fc epsilon RI beta) variant had more severe asthma symptoms.²³ Studies from Saudi Arabia have also identified urbanization, family history of atopy, parental smoking, and diet as important risk factors for asthma in children.^{13–15,24}

In conclusion, the results of the present study showed that the prevalence rates of reported symptoms and diagnoses of asthma, allergic rhinitis and atopic eczema in Omani schoolchildren are not only high, but are also associated with significant morbidity and under-recognition. The causes of these findings remain speculative, as there are no data on the prevalence of the various risk factors for the development of asthma and other allergic diseases. Participation in ISAAC Phases II and III may define some of the risk factors for the three allergic conditions. More effort is also required to investigate the causes of 'under-diagnosis' and possible 'under-treatment' of these conditions in the country in order to achieve efficient control and management plans.

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APPENDIX I. ISAAC Phase I Core Questionnaire

A. Asthma

1. Has your child ever had wheezing or whistling in the chest at any time in the past? Yes / No
If you have answered 'No' please skip to question 6.
2. Has your child had wheezing or whistling in the chest in the last 12 months? Yes / No
If you have answered 'No' please skip to question 6.
3. How many attacks of wheezing has your child had in the last 12 months? None / 1–3 / 4–12 / > 12
4. In the last 12 months, how often on the average, has your child sleep been disturbed due to wheezing?
Never woken with wheezing / less than one night per week / one or more nights per week.
5. In the last 12 months, has wheezing ever been severe enough to limit your child speech to only one or two words at a time between breaths? Yes / No
6. Has your child ever had asthma? Yes / No
7. In the last 12 months, has your child chest sounded wheezy during or after exercise? Yes / No
8. In the last 12 months, has your child had a dry cough at night apart from a cough associated with a cold or flu? Yes / No

B. Allergic rhinitis

1. Has your child ever had a problem with sneezing or blocked nose when he/she did not have a cold or flu? Yes / No
If you have answered 'No' please skip to question 6.

2. In the past 12 months, has your child had a problem with sneezing, or runny or blocked nose when he/she did not have flu? Yes / No
If you have answered 'No' please skip to question 6.
3. In the past 12 months, has this nose problem been accompanied by itchy-watery eyes? Yes / No
4. In which of the past 12 months did this occur?
5. In the past 12 months, how much did this nose problem interfere with your child activities? Not at all / A little / A moderate amount / A lot
6. Has your child ever had hay fever? Yes / No / Don't know

C. Atopic eczema

1. Has your child ever had an itchy rash that was coming and going for at least 6 months? Yes / No
If you have answered 'No' please skip to question 6.
 2. Has your child had itchy rash at any time in the last 12 months? Yes / No
If you have answered 'No' please skip to question 6.
 3. Has this itchy rash at any time affected any of the following places: the folds of the elbows, behind the knees, in front of the ankles, under the buttocks, around the neck, ears or eyes? Yes / No
 4. Has this rash cleared completely at any time in the last 12 months? Yes / No
 5. In the last 12 months, how often, on average, has your child been kept a wake at night by this itchy rash? Never / less than one night per week / one or more nights per week.
 6. Has your child ever had eczema? Yes / No / Don't know
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