

Schoolboys in urban industrial environments: are they at increased risk of bronchial asthma?

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تلاميذ المدارس في البيئات الحضرية الصناعية، هل هم أكثر تعرضاً للربو القصبي؟

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خلاصة: هذه دراسة مقطعية كان هدفها المقارنة بين انتشار الربو القصبي (الشعبي) بين التلاميذ السعوديين في مدينة ينبع الصناعية وفي قريتين غير صناعيتين. فتم في سنة 1993 توزيع استبانات على 375 تلميذاً ليقوم آباؤهم بملئها. وأظهرت النتائج أن معدلات انتشار الربو (المشخص عن طريق الاستبيانات) في مدينة ينبع الصناعية وفي قريتي الفراش والغافور كانت 12.6% و4.3% و16% على التوالي. أما معدل انتشار الربو المشخص من قِبَل الأطباء في المناطق الثلاث فكان 13.9% و2.2% و13.7% على التوالي. ولم يكن هناك فرق إحصائي جوهري بين طريقتي التشخيص المذكورتين.

ABSTRACT The objective of this cross-sectional study was to compare the prevalence of bronchial asthma among Saudi schoolboys in Yanbu Industrial City and in two non-industrial villages. In 1993, questionnaires were distributed to 375 schoolboys for completion by their parents. The prevalence of questionnaire-diagnosed asthma in Yanbu Industrial City, and in the villages of Al-Furash and Al-Gafure, was 12.6%, 4.3% and 16% respectively. The prevalence of physician-diagnosed asthma in the three areas was 13.9%, 2.2% and 13.7% respectively. There was no significant difference between the two methods of diagnosis.

Les écoliers en milieu urbain industriel: sont-ils exposés à un plus grand risque d'asthme bronchique?

RESUME L'objectif de cette étude transversale était de comparer la prévalence de l'asthme bronchique chez des écoliers saoudiens dans la ville industrielle de Yanbu et dans deux localités non industrielles. En 1993, des questionnaires ont été distribués à 375 écoliers pour les faire remplir par leurs parents. La prévalence de l'asthme diagnostiqué à travers les réponses au questionnaire dans la ville industrielle du Yanbu et dans les localités de Al-Furash et Al-Gafure était respectivement de 12,6%, 4,3% et 16%. La prévalence de l'asthme bronchique diagnostiqué par un médecin dans ces trois lieux était respectivement de 13,9%, 2,2% et 13,7%. Il n'y a pas de différence significative entre les deux méthodes de diagnostic.

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Introduction

Bronchial asthma is one of the most prevalent chronic lung diseases [1], particularly among children [2-4]. In Saudi Arabia, it is estimated that up to 11.5% of children suffer wheezes [5]. For reasons that remain unclear, the prevalence of bronchial asthma is increasing [1]. Morbidity and mortality associated with asthma has also continued to increase despite advances in treatment and management [2]. Bronchial asthma in children is known to vary from region to region due to the variability of extrinsic allergens that play a major role in sensitizing susceptible children, thereby producing the symptoms of the disease [5]. As an allergic disease, these environmental factors are known to be of more importance than genetic factors in the etiology of bronchial asthma [5]. Not surprisingly, bronchial asthma is more prevalent in industrialized than in developing countries [2].

In Saudi Arabia, a developing country evolving into an industrial one, few studies have been conducted to investigate the various aspects of this health problem — including prevalence — among children [1,2,5-11]. We know of no study that has documented the impact of industry on the prevalence of bronchial asthma among schoolchildren. The objective of the present study was to determine the prevalence of bronchial asthma among Saudi schoolboys at Yanbu Industrial City (Yanbu) and to compare this with two non-industrial villages.

Subjects and methods

In 1993, elementary- and preparatory-level male schoolchildren were randomly chosen for study from schools in the industrial city of Yanbu and from Al-Furash (a non-agri-

culture based-village) and Al-Gafure (an agriculture-based village). Yanbu is located on the Red Sea coast, in western Saudi Arabia, approximately 350 km north of Jeddah. The Yanbu industrial project covers an area of 180 km², including a 30 km² residential area located to the north-west and upwind of the industrial area. This area is separated from the industrial area by a 1-km-wide buffer zone.

Al-Furash is a non-agricultural village situated near the old road to the holy city of Mecca and is 50 km from Medina. Al-Gafure is a small agricultural village where palm trees and vegetables are cultivated. These two villages were selected as being the most feasible and accessible, from the point of view of comparison with Yanbu.

The combined male student population of the three areas, in the age range 5-15 years, was 3750. We randomly selected 10% of this total for our sample (375 students). This was based on the estimated prevalence rate computed from a pilot study carried out prior to the main phase of the study. The selection of the students was by simple random sampling from the pool of students in each area (within the age range 5-15 years). The number of students chosen from each area was based on 10% of that area's total student population in the specified age range. Of the 375 students making up the sample, 206 (55%) of the sample were from Yanbu, 75 (20%) were from Al-Gafure and 94 (25%) from Al-Furash.

The methods used included a self-administered pre-tested and pre-coded questionnaire directed at parents. The questionnaire was subjected to a reliability test. This testing rated the questionnaire as being up to 91% reliable. The questionnaire was a modified version of both the Medical Research Council questionnaire [12], and a questionnaire previously used in a

similar study among Saudi schoolchildren [13].

The definition of asthma used in the study was the modified Medical Research Council definition [14]. Children were identified as asthmatic if their parents responded "yes" to any of the following questions:

- Has your child ever had an attack of "wheezing" — a whistling noise that comes from the chest?
- Did your child get attacks of shortness of breath with wheezing?
- Does the breathing of your child become normal in between attacks?

Children whose parents had sought a diagnosis from a physician, who had confirmed asthma (based on history, physical examination and formal testing if required), were considered as "physician-diagnosed asthmatics".

In all areas, the children and their parents were asked to supply the following personal details:

- age
- area of residence
- history of asthma
- history of wheeze
- cough
- passive smoking
- hay fever
- family history of respiratory allergies.

Data were analysed using *Epi-Info* and *SPSS*. Chi-squared differences were calculated and the statistical significance of contingency tables assessed.

Results

Characteristics of the children

A total of 375 schoolboys were included in the study. The response rate was 92% in

Yanbu Industrial City, 95% in Al-Furash and 97% in Al-Gafure villages. A total of 206 (55%) students were from Yanbu, 75 (20%) were from Al-Gafure and 94 (25%) were from Al-Furash.

The age range of the students was 6–15 years. The mean age \pm standard deviation was 10.5 ± 3.2 years. The majority of the students (87%) were under 14 years of age. The mean age of the students in Yanbu was 9.6 ± 2.8 years — significantly lower than that found in both Al-Furash (11.6 ± 3.2 years) and Al-Gafure (11.7 ± 3.2 years) ($P < 0.0001$).

Prevalence of bronchial asthma

The cumulative prevalence of questionnaire-diagnosed asthma (QDA) in the total sample was 11.2%. The cumulative prevalence of QDA was highest in Al-Gafure (16%), followed by Yanbu (12.6%), with the lowest prevalence (4.3%) recorded in Al-Furash. The difference in the prevalence between the three areas was statistically significant ($P < 0.03$) (Table 1). The highest prevalence of QDA (17.8%) was among schoolboys aged 12–14 years, although there was no significant difference in the prevalence of QDA between age groups.

The overall prevalence of physician-diagnosed asthma (PDA) was found to be 11%. Almost the same prevalence of PDA was found in Yanbu and Al-Gafure (13.9% and 13.7%, respectively). The prevalence in Al-Furash was 2.2%. The difference in prevalence between the three areas was statistically significant ($P < 0.0093$) (Table 2). The mean age at diagnosis of PDA was 4.4 ± 4.3 years. Exactly 70% of PDA cases were known to be so before the age of 5 years. Table 3 shows the prevalence of respiratory symptoms by area of residence.

Table 1 Prevalence of questionnaire-diagnosed asthma by area of residence, Saudi Arabia, 1993

Area	Yes		No		Total
	No.	%	No.	%	
Al-Furash	4	4.3	90	95.7	94
Al-Gafure	12	16.0	63	84.0	75
Yanbu	26	12.6	180	87.4	206
Total	42	11.2	333	88.8	375

$P < 0.03$ (chi-squared test)

Table 2 Prevalence of physician-diagnosed asthma by area of residence, Saudi Arabia, 1993

Area	Yes		No		Total
	No.	%	No.	%	
Al-Furash	2	2.2	88	97.8	90
Al-Gafure	10	13.7	63	86.3	73
Yanbu	28	13.9	174	86.1	202
Total	40	11.0	325	89.0	365 ^a

^a10 missing cases: Al-Furash 4; Al-Gafure 2; Yanbu 4

$P < 0.0093$ (chi-squared test)

Comparison of QDA and PDA

Validation of questionnaire-diagnosed compared to physician-diagnosed asthma yielded a sensitivity rate of 82.5%. The diagnosed asthma specificity of the questionnaire was 97.2%, with a false positive rate of 2.8% and a false negative rate of 17.5%. Comparison between QDA and PDA results using the McNemar test yielded $Z = 0.50$, which was not significant ($P > 0.05$) (Table 4).

Discussion

Compared with similar studies using self-administered questionnaires in the field of bronchial asthma in children, the high response rate of over 95% was an encouraging observation [15,16]. Another important observation in this work is related to the diagnosis of bronchial asthma at an early age, irrespective of the variation and availability of health services in the three areas investigated. In our study, 70% of asthmatic boys were diagnosed by physicians by age 5 years and approximately 75% by age

Table 3 Prevalence of respiratory symptoms by area of residence, Saudi Arabia, 1993

Symptom	Al-Furash		Al-Gafure		Yanbu		P-value ^a
	No.	%	No.	%	No.	%	
Dyspnoea	2	2.1	16	21.9	21	1.4	0.0002
Dyspnoea (after exercise)	8	8.7	16	21.9	33	16.5	NS
Cough	0	0	11	15.3	20	9.8	0.001
Cumulative (ever wheeze)	5	5.5	19	26.0	36	18.0	0.001
Current wheeze	1	1.1	12	16.4	18	9.0	0.002

^achi-squared test

NS = not significant

6 years. This accords with the findings of others [17].

Unfortunately, environmental monitoring was not carried out in this study to determine the level of air pollution in the three areas relative to one another and to other places in the country. However, ozone and total suspended particulates were found in another study to be above acceptable levels in an identical industrial city, Al-Jubail [18].

Inferences based on comparisons of prevalence studies of bronchial asthma should be considered cautiously [19] because of the unavailability of a universally acceptable definition, and the variation in methodologies and design of prevalence studies, e.g. current/cumulative prevalence [2,19]. Prevalence studies using PDA only will tend to underestimate the prevalence of the disease. The prevalence rate of QDA in Yanbu was 12.6%. This lies almost in the middle of the range 5.3%–18% reported by other researchers using a definition similar to ours [20–22]. It is a much higher prevalence, however, than the range 0%–8.1% reported by researchers using alternative definitions to that used in our study [23–26]. Our study suggests then that the prevalence of bronchial asthma in schoolboys in Yanbu is moderately high. Using the criteria of QDA, the higher prevalence of bron-

chial asthma among schoolchildren in Yanbu compared with Al-Furash indicates the increased risk of developing bronchial asthma in an industrialized urban environment over that of non-agricultural rural areas. However, the higher prevalence of QDA among children in the agricultural village of Al-Gafure was not expected. To the best of our knowledge, no studies comparing prevalence of asthma in agricultural areas with that of industrial areas have been carried out. However, one large multi-occupational group study did find that the highest prevalence rate of asthma was among farmers, compared with other occupations in the study [27]. This may be related to their increased exposure to pollens, mites, pesticides and domesticated animals, including goats [28,29].

When using PDA as the criteria, prevalence in the three areas was highest in Yanbu (13.9%). This rate is higher than that reported in Saudi Arabia's three largest cities — Jeddah (9.8%), Riyadh (9.3%) and Dammam (3.6%) among primary-school children aged 7–12 years [2]. It is also moderately high compared to the range of 2.5%–17.4% reported elsewhere [16,30–33].

Our study may be considered a baseline for further, more comprehensive future studies. Based on the present results, au-

Table 4 Comparison of asthma as diagnosed by questionnaire and as diagnosed by physician

Asthma diagnosed by questionnaire	Physician-diagnosed asthma				Total	
	Yes		No		No.	%
	No.	%	No.	%	No.	%
Yes	33	82.5	9	2.8	42	11.5
No	7	17.5	316	97.2	323	88.5
Total	40		325		365	

McNemar P-value > 0.05

thorities in the Ministries of Health, Agriculture and Industry should take steps towards addressing the problem, by studying its potential causes and by initiating prevention measures.

The questionnaire used in this study was found to have a moderate sensitivity

and a high specificity in determining the prevalence of asthma in schoolboys. Studies using similar tools should be encouraged, particularly for screening purposes during the school-entry medical examination, or afterwards, among school-aged children.

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