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Factors associated with tuberculin reactivity among children in United Arab Emirates

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A cross-sectional survey of tuberculin skin reactivity was conducted in Al-Ain, United Arab Emirates (U.A.E.) between January and June 1994, to find out the prevalence rate of tuberculosis infection. A pre-designed questionnaire was used to collect details of BCG scar, age, sex, residence area, nationality, education, type of house, number of rooms, family size and household contact history of tuberculosis. A total of 785 students were screened, of whom 547 gave a history of BCG vaccination in the past and 238 were BCG-negative. Among BCG-negative children aged 5–11 years and 12–15 years, only 6·5% and 9·3%, respectively, had a positive Mantoux reaction — a rate lower than most Third World countries, but higher than developed countries where under 2% of children are tuberculin reactors. A general linear model with positive Mantoux reaction as the dependent variable was fitted to the data to examine the joint effect of age, sex, residential area, number of rooms at home, family size and BCG vaccine history. The Mantoux reaction was entered as positive and a number of statistically significant associations were found between positive Mantoux test >10 mm and: age (P=0·0018); sex (P=0·0281); residential area (P<0·0001); number of rooms (P=0·0017); and BCG vaccine history (P<0·0001). However, family size did not have any statistical effect on tuberculin testing (Mantoux test >10 mm). The prevalence (8%) in the 5–14 years age group puts U.A.E. between low (2%) and middle (14%) prevalence countries, according to the classification of the International Union Against Tuberculosis. This calls for continuation of free treatment of active cases and increased efforts towards screening of contacts.

Introduction

There has been a marked decline in morbidity and mortality from tuberculosis all over the world, but it remains a major health problem in most developing countries (1) and especially in neighbouring Gulf countries (2–7).

The overall incidence of tuberculosis has declined steadily in U.A.E. specially over the past decade. BCG vaccination shortly after birth has been shown to protect against tuberculosis in many countries (8). The policy of the Ministry of Health in U.A.E. is to offer BCG vaccinations to all babies within the first few days of birth. However, most cases of tuberculosis in U.A.E. were detected among expatriates who had recently arrived in the country. It is worth noting that the issuing of a residence visa is subject to a tuberculosis clearance. All new expatriates are routinely screened for tuberculosis as well as other diseases that might endanger public health as per the law of communicable diseases (9). An epidemiological study of tuberculosis infection in U.A.E. was conducted as a small pilot study in a semi-rural area among BCG-negative children aged 0–14 years; only 8·3% had a positive Mantoux reaction >10 mm (10).

A World Health Organization (WHO) Expert Committee on tuberculosis (11) has recommended that the age-specific prevalence of tuberculous infection can be assessed in a community by tuberculin skin survey. The WHO Expert Committee (12) also noted that 'mass miniature radiography is a very expensive screening procedure for tuberculosis, even when the prevalence is high'. This recommendation has been reaffirmed by a joint International Union Against Tuberculosis (IUAT)/WHO study group on tuberculosis control in 1982 (13). In view of this recommendation, chest radiography would be unnecessary and inadvisable for the purpose of a sample

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survey to determine the extent of the tuberculosis problem in U.A.E.

To formulate a national tuberculosis control programme, it is necessary to have baseline data on the prevalence of the disease and its characteristics in various parts of the country. No country-wide epidemiological data on tuberculosis are available for U.A.E. Tuberculosis in U.A.E., like other Gulf countries with multi-national inhabitants, is one of the major public health problems (7). The aim of the present study is to determine the epidemiological prevalence rate of tuberculous infection in Al-Ain, U.A.E., using tuberculin test positivity, as recommended by WHO (11–13).

Materials and Methods

A cross-sectional tuberculosis survey of primary and secondary schools was conducted between January and June 1994 in Al-Ain City, U.A.E. A team of an experienced school physician and nurses were recruited and trained to achieve the study objectives. This included an interview using a pre-designed questionnaire, and Mantoux skin testing procedure. The study was conducted in both urban and rural areas of Al-Ain City, U.A.E.

TYPE AND SIZE OF SAMPLE

According to the few limited studies available, the prevalence of tuberculosis in U.A.E. vary from 8% to 10% (7,9,10). Because of this variability, a fairly large sample was needed. To derive the required sample size, α (level of significance) was set at 0·05, and 1-b (power) was set at 0·80. To fulfil the requirement of the objectives, 800 subjects were needed in order to be 95% confident of a true result (14). The subjects were all aged 5–14 years. A multi-stage sampling technique was used and the schoolchildren were selected randomly. Stratification allowed both urban and rural areas to be proportionally represented. The survey was based on stratified sampling methods used in the WHO Expanded Programme on Immunization (EPI) (15). The questionnaires and administration team were the same in urban and rural areas. In order to have a fair representation of rural and urban residents in the sample, children attending school at their respective living areas were surveyed. Urban areas were those districts situated within the periphery of the city of Al-Ain. Rural areas were defined as those villages located immediately outside the Al-Ain City limits. Since 80% of the population live in urban areas, 80% of the sample size was allocated to the urban area and the remaining 20% to the rural communities. The list of names of government schools was obtained from the Director of General Education in the Ministry of Education. Government schools in Al-Ain are segregated according to the sexes.

As recommended by WHO's EPI (15) sampling method instead of making a cumulative list of village populations, a cumulative list of school populations was made. The total school population was then divided by the number of clusters (no. of schools) needed to determine the sampling interval (a). Likewise, a random number (n) was selected within the size of sampling interval. The first school selected attended by the nth child; the second school selected was that attended by the nth$+a$ child; the third by the nth$+2a$ child etc., until eight schools were identified. From an attendance list, children were randomly selected to provide n. This process was repeated until all eight schools were identified. School attendance was obtained from the Director of Education or from the randomly selected headmaster of the selected school and from this list, a child was randomly chosen. The majority of U.A.E. national students are located in eight districts. In the first stage, one school from each of these eight districts was selected randomly thus overcoming the so-called 'cluster effect' that could have occurred if the schools were put into one pool and names were randomly selected. This could possibly have resulted in schools in only one area of the town being represented. In the rural area, two schools for boys and one school for girls were selected randomly. Similarly, the classrooms and schoolchildren were selected in the second and third stages using the same simple random sampling procedure that resulted in the selection of 800 students (determined sample size) who proportionally represented the study population.

Mantoux test was given to 800 subjects but analyses were based on only 785 subjects due to incomplete data and/or failure to be available for reading the test.

QUESTIONNAIRE

Using a pre-designed questionnaire, the following information was recorded: age; sex; nationality (U.A.E. nationals only); education (primary, or secondary); type of house; number of rooms; and family size. The presence or absence of BCG scar was read blindly while the history of receiving BCG vaccination was confirmed after verification of the immunization health card by the nurses (immunization health card provided by the Ministry of Health). The questionnaire was designed so that all information relevant to the objectives of this project could be entered in a coded form convenient for subsequent computer processing. The information was filled in

by the Research Officer or School Nurse in the school at the screening.

Data on symptoms and diseases of the respiratory system were obtained from each subject. These included history of cough, sputum production, or fever for more than 1 month at the time of the survey. Past history of tuberculosis, history of any other chronic lung disease and family history of tuberculosis were also recorded.

TUBERCULIN TESTING

The Mantoux test was performed using five tuberculin units (5 TU) of the purified protein derivative (PPD) Tubersol Diagnostic Antigen Connaught (Willowdale, Canada). Using a tuberculin syringe, 0·1 ml 5 TU was injected intradermally on the volar surface of the forearm. The test was read 48 h later. Individuals with induration measuring 10 mm or more were considered to have a positive reaction (4,5). A positive reaction indicates a sensitivity to tuberculin which may be the result of a previous infection with *Mycobacterium tuberculosis*. Induration measuring 5–9 mm indicates a doubtful or intermediate reaction. In the phase of negative contact history with active disease, the intermediate reaction was considered as either previous exposure to environmental non-tuberculous mycobacteria or a reaction to earlier BCG vaccination. Induration of less than 5 mm was interpreted as a negative reaction (4,5).

STATISTICAL ANALYSES

The data collected was coded for computer entry and processed using the SAS statistical computer package (16). Descriptive statistics included frequency tables and cross-tabulations. The Chi-square test was used to investigate any trend with age, as well as the association between BCG history and both positive and negative Mantoux reaction. A general linear model was used to explore the joint effects of demographic variables. The effect of the various variables; such as age, sex, number of rooms, family size, education, and BCG vaccine history; on the prevalence of tuberculous infection (as measured by tuberculin test) was evaluated using a general linear model (17). Probability less or equal to 0·05 was considered as the cut-off value for significance.

Results

Table 1 shows the characteristics of the population surveyed. Mantoux test was given to 800 individuals, but the statistical analyses were based on only 785 individuals due to incomplete data for the rest; mainly failure to be available for reading the test. The 'nearly equal' number of males (54·9%) and females (45·1%) reflects the success of the team to overcome the reluctance of conservative U.A.E. families to allow screening of females. Of the 785 individuals, 69·2% had BCG-positive vaccine history and 238 (30·1%) had BCG-negative history or their vaccination history was not known. Also, 54·5% had a BCG scar present and 45·5% had no BCG scar.

Table 1 Characteristics of the population surveyed

Population characteristics	Number	Percentage
Total number screened	785	100
Age (years):		
5–11	506	64·5
12–15	279	35·5
Sex:		
Male	431	54·9
Female	354	45·1
Residence:		
Urban	644	82
Rural	141	18
Type of house:		
Villa	215	27·4
Semi-villa	140	17·8
Flat, Apt.	69	8·8
Mud house	361	46·0
Number of rooms:		
<4	238	28·3
4–6	505	64·3
>7	42	5·4
Members of family:		
<3	151	19·2
4–7	485	61·8
>8	149	19·0
Education:		
Primary	506	64·5
Secondary	279	35·5
BCG vaccine history:		
Positive	544	69·6
Negative	238	30·4
BCG scar:		
Present	428	54·5
Absent	357	45·5

The effect of age on the size of the Mantoux reaction in subjects with negative and positive BCG history is shown in Table 2. It is clear from the table that positive Mantoux reaction (10 mm or above) increased significantly with age. Previous BCG vaccination increased the incidence of positive reactions, decreased the incidence of negative reactions, but had no effect on intermediate reactions (5–9 mm). Positive Mantoux reaction was significantly higher among BCG-positive subjects in all age groups. A Chi-square test for trends shows a significant

Table 2 Effect of age on the size of Mantoux reaction in subjects with negative and positive BCG histories

Age (years)		5–11	12–14	Total	
Mantoux test (mm)	BCG history	No. (%)	No. (%)	No. (%)	
0–4	Negative	96/109 (88)	99/129 (76·7)	195/238 (82)	$P<0·04$
0–4	Positive	322/397 (81)	109/147 (74·1)	431/544 (79·2)	n.s.
5–9	Negative	6/109 (5·5)	18/129 (14·0)	24/238 (10)	$P<0·05$
5–9	Positive	41/397 (10·4)	9/147 (6·1)	50/544 (9·1)	n.s.
10>	Negative	7/109 (6·5)	12/129 (9.3)	19/238 (8)	n.s.
10>	Positive	34/397 (8·6)	29/147 (19·7)	63/544 (11·6)	$P<0·01$

BCG-negative 5–9 mm *vs.* BCG-positive 5–9 mm, Chi-square=20·34, d.f.=1, $P<0·0001$.
BCG-negative>10 mm *vs.* BCG-positive >10 mm, Chi-square=1·10, d.f.=1, $P=0·295$.

Table 3 General linear model with positive Mantoux test >10 mm reaction was fitted to the data to examine joint effects of demographic explanatory variables

Explanatory variables	Regression coefficient	Standard error	*t*-statistics test	*P*-value
Age	0·506	0·161	3·125	0·0018
Sex	0·336	0·153	2·200	0·0281
No. rooms	−0·361	0·114	−3·157	0·0017
Residence	0·777	0·193	4·013	0·0001
BCG vaccine history	−0·733	0·191	−3·831	0·0001
Family size	0·030	0·062	0·0489	0·6253

increase of positive Mantoux reaction with increasing age among subjects with both negative and positive BCG history (BCG-negative Mantoux 5–9 mm and BCG-positive Mantoux 10 mm).

A general linear model with positive Mantoux reaction as the dependent variable was fitted to the data to examine the joint effect of age, sex, residential area, number of rooms at home, family size or number of members at home, and BCG vaccine history. Table 3 shows data for positive Mantoux reactions. A number of statistically significant associations were found between positive Mantoux test >10 mm and: age ($P=0·0018$); sex ($P=0·0281$); residential area ($P<0·0001$); number of rooms ($P=0·0017$); and BCG vaccine history ($P<0·0001$). However, family size did not have any statistical effect on tuberculin testing (Mantoux test >10 mm).

There was no significant effect of clinical history, presence of cough, chest problems or symptoms described in the WHO methods on the prevalence of positive Mantoux test.

Discussion

The rise of tuberculosis prevalence with age is similar to findings in other countries (4,5,18–25) and represents increased and cumulative exposure in older subjects as well as reduced contact with open tuberculosis cases for those subjects born in the last 15 yr (Table 4). As per the classification proposed by the IUAT (18), it is clear than in terms of exposure to risk of infection (with or without disease), the 8% prevalence rate in 5–14-year-olds in Al-Ain, U.A.E., ranks U.A.E. midway between low (2%) and middle (14%) prevalence countries. The rise of tuberculosis prevalence with age is similar to findings in other neighbouring Gulf countries (4–6) (Table 4). Urban areas have a higher prevalence of positive Mantoux test than rural areas. This could be explained by the fact that in Al-Ain, U.A.E., people in urban areas are more likely than those in rural areas to come into contact with thousands of people visiting regularly from different parts of the U.A.E. and other parts of the world.

Table 4 Prevalence of infection in children in various countries compared with the classification of the International Union Against Tuberculosis

Country	Reference	Study period	Age (years)	Prevalence of infection (%)
Saudi Arabia	4	1990	5–14	4
Saudi Arabia	5	1991	5–14	5
Bahrain	7	1991	5–14	6·8
India – rural	19	1968	5–14	15·4
South Africa – Black	20	1974	10–14	21·4
Norway	21	1970	5–14	1
Gambia – rural	22	1985	<10	20
Northern Lebanon	23	1980	7–17	4
U.S.A.	24	1973	5–14	1
Edinburgh	25	1986	5–14	8

The prevalence of tuberculosis in the 5–14 years age group was 8%, which places U.A.E. midway between low (2%) and middle (14%) prevalence countries (18). This reflects diminished exposure of children to open cases of tuberculosis in the community.

The results also indicate the current practice of giving BCG vaccination in U.A.E. in the first few days after birth. The WHO Expert Committee on Tuberculosis (11) recommends this should be continued until the percentage of tuberculin reactors at school-entering age drops to 2%. Presently, the prevalence rate of 6·5% in age group 5–11 years rises to 9·3% in age group 11–14 years. Second vaccination should also be given at school-leaving age. The WHO Expert Committee on Tuberculosis recommends that revaccination would be necessary in countries with high transmission.

However, the current policy of screening all foreign labour within 4 weeks of entering U.A.E. for active tuberculosis, should continue until the nationwide survey is completed. We strongly recommend the continuation of these measures in U.A.E. Finally, we recommend that a similar study should be done in about 5 yr from now in order to make comparisons with these findings and determine the prevailing trends or changes.

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