The prevalence of tuberculin reactivity in Saudi Arabia in children aged 5–14 years is 6% (which puts it in the rank of middle prevalence countries). However, two spots of high prevalence exist: the City of Jeddah, and the urban centers in the Southern Region with statistically significant differences between Saudis and non-Saudis; these could have resulted from the pattern of settlers in Jeddah, and close social contact between the southern region and the Republic of Yemen. The incidence of smear-positive pulmonary cases in Riyadh in 1991–92 was 15.2 per 100 000 and I predicted the nationwide incidence of all cases to be 30 per 100 000 which is about double the official notifications. The figures are 2–4 times higher than industrialized countries. There are alarming data of considerably high microbial resistance to antituberculosis drugs particularly in the Western and Southern Regions (where the majority of isolates are multi-drug resistant). The microbial resistance and the high infection rates brought by legal and illegal settlers from poor countries are considered to be the greatest threat to future control of tuberculosis in Saudi Arabia. The review makes several recommendations.

Keywords: Tuberculosis: epidemiology, prevention, control. Tuberculin test.


With the exception of the Ministry of Health (MOH), scientific institutions in the kingdom pay very little attention to the old ‘captain of men of death’. The attention given to tuberculosis by academic institutions is dwarfed by the interest generated by AIDS; in spite of the fact that AIDS is uncommon in this country, preventable but not curable, while tuberculosis is common, preventable, and curable. Not only is there a dearth of knowledge on tuberculosis in Saudi Arabia but whatever little information is available is fragmental or inaccurate. The notification reports of active cases from the Middle East are notoriously inaccurate: Sudan and Egypt reported to the World Health Organization in 1990 that they have unseated Denmark as the country with the lowest incidence of active cases worldwide.

The following review summarizes the data available from Saudi Arabia, and attempts an analysis of the tuberculosis eradication policies adopted by the Ministry of Health. In view of the size of this review article, only references related to Saudi Arabia have been printed.

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Epidemiology of Tuberculosis in Saudi Arabia

The prevalence of infection

Infection by tuberculosis results in a primary focus (usually in the lung) and conversion from a negative to a positive skin tuberculin reaction. Only about 5% of infected subjects break into active disease in the first 2 years following infection, with about another 5–10% developing active disease during the rest of the subject’s life.

The American Thoracic Society considers a skin induration of 10 mm or more following Mantoux test with 5 PPD units as evidence of tuberculosis infection. Using this parameter in the first comprehensive and nationwide with urban/rural stratification survey in Saudi Arabia, we reported on the prevalence of infection.\(^2\) In the general population, 33% of subjects were infected, peaking to 56% in those aged 45 years and upwards. If the prevalence in children aged 5–14 years (more representative of recent trends) is considered on a regional basis, then interesting conclusions can be made. The average prevalence in children was 6% which places it into the middle prevalence (2–14%) category according to the classification proposed by the International Union Against Tuberculosis. The prevalence was much the same in all the five regions except for two spots of high prevalence. The first of these was in the City of Jeddah in the Western Region (20%)\(^2\) and the urban centres in the Southern Region (11.8%).\(^3\) Moreover, the Western and Southern Regions (and not Central, Eastern, Northern) were the only ones where the difference between Saudis and non-Saudis was statistically significant. We speculated that these findings represented the effect of illegal settlers in the City of Jeddah (which was a special geographic situation),\(^2\) and the proximity and close social links of the Southern Region to the Republic of Yemen\(^3\) which has one of the highest incidences of tuberculosis in the world (a situation akin to that seen at the southern border of the USA with Mexico).

Although an important parameter, the prevalence of infection does not necessarily indicate recent trends in the community, as the infection might have been acquired in the past. A more representative parameter would be the annual risk of infection.

Annual risk of infection

This gives the percentage of unvaccinated children who convert to positive Mantoux in any given year and is acknowledged to be the best indicator of the attacking force of tuberculosis in the community. The author\(^4\) found it to average 0.56% in Saudi Arabia in the period from 1975 to 1986. More importantly, there was no trend for decline over the 10-year period. This implies that children still come into contact with open (infective) cases, at a rate five times that of European countries where rates have declined to around 0.1%.

This is a significant finding given the fact that tuberculosis is not highly infectious: only about 20% of close home contacts of smear-positive index cases acquire infection, and less than 4% of casual contacts or close contacts of smear-negative cases. An annual risk of infection of 0.56% means that the average child has about a 10% risk of becoming a casual contact (or a 2% risk of being a close contact) every year. Why should that be the case given the wide availability of free treatment with rifampicin-containing regimens? We re-analysed the data for annual risk of infection and found that there were three widely differing bands in 1986:

1. Jeddah and urban centres in the Southern Region: 1–1.5% (more in Jeddah).
2. Riyadh, Al Khobar: 0.5%.
3. Rural communities all over the kingdom: 0.1% (a rate similar to rich European countries).

These three bands represent in my opinion\(^2\) three different social realities. 1) Jeddah and southern cities with the influx of illegal settlers (unscreened) in Jeddah\(^2\) and Yemenis nationals in the south\(^3\) (who until late 1990 were exempt from screening procedures enforced on foreigners). 2) Other urban centres with a large concentration of foreign workers who are nevertheless screened for tuberculosis. 3) Small rural centers predominantly made up of Saudis with good access to medical facilities.

Incidence of active cases

Notification of active cases to the Ministry of Health is not compulsory. In 1991 figures were as follows for pulmonary tuberculosis:

- Saudis: 1106 (9 per 100 000; using the 1992 population census)
- Non-Saudis: 1115 (27 per 100 000)
- Total: 2221 (13 per 100 000)

and for non-pulmonary tuberculosis:

- Saudis: 188 (1.5 per 100 000)
- Non-Saudis: 105 (2.6 per 100 000)
- Total: 293 (1.8 per 100 000)
The World Health Organization in its annual report recognized that the reports it received from the Third World represent gross undernotification. To put the notification figures in Saudi Arabia in perspective we have to realize that the incidence in wealthy European countries and Canada varies between 7 and 25 per 100,000 in the White population and between 50 and 100 per 100,000 in immigrants. On this basis we suspect that the figures in Saudi Arabia represent slight undernotification. Moreover, in a research project conducted by workers in King Saud University over 2000 new cases of pulmonary tuberculosis were recorded in seven tuberculosis hospitals only in the year 1412 (12 July 1991–30 June 1992). The same workers estimate the nationwide total to be over 4000 with an incidence of 28 per 100,000.

Other data also prove that the annual incidence is higher than reported. It is well documented that the annual risk of infection could predict the incidence of smear positive cases: For every 1% annual risk 50–60 per 100,000 smear-positive cases would occur in an underdeveloped country, and would be one-third less in a country with good medical facilities. Therefore, Saudi Arabia (with an annual risk of infection of 0.5%) is expected to have 0.50 × 50 × 2/3 = 16 smear-positive cases per 100,000. As smear-positive cases account for about 50% of all cases, Saudi Arabia would be expected to have an incidence of about 30 per 100,000 (and not 13 + 1.8 per 100,000 as in the notifications to the MOH). Naturally, the responsibility for undernotification should be born by the hospitals and not the MOH.

In order to test the accuracy of the above calculations, the author compared the predicted incidence with the actual incidence of active cases in the City of Riyadh. The annual risk of infection was 0.5% (similar to the whole nation) and the predicted incidence, therefore, was 16.6 smear-positive cases. The author visited all hospitals and centers which performed smear and cultures in Riyadh and documented 289 cases of smear-positive pulmonary tuberculosis (and 399 culture-positive cases) in the year from mid-1991 to mid-1992. As the population of Riyadh in 1992 census was 1,900,000, the incidence of smear-positive cases was therefore 289 × 100,000/1,900,000 = 15.2 per 100,000 (similar to the predicted 16.6).

Advanced and drug-resistant tuberculosis

In 1600 consecutive patients seen with tuberculosis in Riyadh Chest Hospital during 1983 (11%) or 1972 had total lung destruction. About half of the latter group were long-term excretors of drug resistant *Mycobacterium tuberculosis*.

The other special problem that could jeopardize the attempt at control of tuberculosis in the kingdom is the presence of foci of drug-resistant tuberculosis. From the published evidence these occur in the Western and Southern Regions (Table 1).

Not only are the resistance rates to individual drugs high, but the majority of isolates were resistant to two or more drugs. The consequences of high resistance and poor compliance with treatment can best be observed in the data obtained from Abha Chest Hospital: Of 142 new cases of active tuberculosis registered in 1412, (12 July 1991–30 June 1992) 84 (or 59%) had bilateral lung involvement seen on chest X-rays (author’s unpublished data).

What could go wrong in Saudi Arabia?

The first area of concern is the high foci of annual risk of infection in cities generally, and in the Western and Southern Regions in particular. These are related (we speculate) to influx of legal

<table>
<thead>
<tr>
<th>Area</th>
<th>Inh (%)</th>
<th>Rif (%)</th>
<th>Strept (%)</th>
<th>Etham (%)</th>
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<tr>
<td>Central Region 1411</td>
<td>7</td>
<td>9</td>
<td>—</td>
<td>2</td>
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<td>Taif Chest Hospital,</td>
<td>6.5</td>
<td>15</td>
<td>16</td>
<td>4</td>
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<td>Gizan Area (1983–1984)</td>
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<tr>
<td>Primary resistance</td>
<td>10</td>
<td>3</td>
<td>5</td>
<td>0</td>
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<tr>
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<td>80</td>
<td>42</td>
<td>53</td>
<td>9</td>
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</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>20</td>
<td>26</td>
<td>4</td>
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</tr>
</tbody>
</table>

Inh = Isoniazid
Rif = Rifampicin
Strept = Streptomycin
Etham = Ethambutol
foreign labour (partly screened in home countries) into all cities, and illegal or unscreened settlers into the Western and Southern Regions respectively. The second area of concern are the microbial resistance figures particularly in the Western and Southern Regions.

It is not incidental that both problems are worse in the Western and Southern Regions. Microbial resistance encourages the spread of infection, and problems are mutually synergistic; settlers from poor countries bring resistant strains and a higher prevalence of infection.

What can be done?

1. The emphasis must be placed on collecting data on the following:
   - annual risk of infection in urban Saudi Arabia (e.g. three times yearly)
   - drug resistance pattern (e.g. twice yearly)
   - relapse rates (e.g. once yearly)

2. Screening by X-ray must take place (in Saudi Arabia) of all workers from countries with a high prevalence; those with infiltrative or cavitary lesions (but not small calcific foci) should be deported. The problem of X-raying everybody, often used as an excuse can be solved by installing an X-ray unit in each of the three international airports.

   (Currently the driver of a family saloon car is X-rayed in Saudi Arabia while the driver of a public bus only presents a health certificate from his home country.)

3. Quality control checks should be carried out on various tuberculosis laboratories and random representative samples of mycobacterial strains should be sent to reference laboratories in the West to check resistance patterns. Treatment of all cases in the Southern Region must be guided by sensitivity tests. (The Tuberculosis Reference Unit of the University of Wales, UK has been providing this service for clinicians in the University and MOH for less than 80 SR per isolate.)

4. A Tuberculosis Medical Officer (general physician trained for 3 months) must be appointed for every 200,000 inhabitants. He will be responsible for visiting tuberculosis units and laboratories, report accurate annual incidence figures and microbial resistance patterns in his catchment area, visit the non-compliant patients at home, and screen close contacts with smear-positive cases.

5. The current tuberculosis hospitals in the kingdom should be maintained. Even in wealthy industrialized countries, scientific authorities are urging the reversal of the trend of the last 30 years whereby separate tuberculosis medical facilities were closed.

6. Life-long isolation of incurable smear-positive cases. The author has come across patients harbouring multiple-drug-resistant strains who were sent home and back to work by treating doctors on the basis that nothing could be done for them.

It would be delusional to assume that Saudi Arabia is immune to the rise of tuberculosis incidence and resistance to treatment that has recently been registered in nearly all countries of the world including the USA and the UK. The only way to foresee future trends is by accumulating, on a regular basis, accurate and nationwide data on annual risks of infection, relapse, and microbial resistance patterns. This is analogous to weather forecasts of future storms, while relying only on incidence of active cases (inaccurate in most countries anyway) is analogous to waiting for the storm to arrive before deciding what action needs to be taken.

Acknowledgement

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