Prevalence of latent tuberculosis infection among multinational healthcare workers in Muhayil Saudi Arabia
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**Objectives** The aim of this work was to assess the prevalence of latent tuberculosis infection (LTBI) in multinational healthcare workers (HCWs) in Muhayil, Saudi Arabia.

**Materials and methods** This work was carried out in 2013 and included all hired HCWs in Muhayil National Hospital (MNH), Muhayil, south of Saudi Arabia. Data were collected from HCWs including age, sex, job category, and country of citizenship. They were examined for LTBI using the tuberculin skin test (TST) after obtaining their consent to perform the test. CXR was also carried out in all participants to (and if needed sputum stain for Mycobacterium tuberculosis smear) for the detection of active disease. Statistical analysis was carried out, and $P$ values less than 0.05 were considered significant.

**Results** Out of the 208 HCWs tested with TST, 47 (22.5%) were positive. The prevalence of LTBI was the highest in the age group of 50 years or more [26.3% ($n = 5$)] and the lowest in the age group 20–29 years [19% ($n = 14$)]. The prevalence of LTBI was the highest in nurses [$28.7% (n = 21)$] and the lowest in physicians [$16.5% (n = 7)$]. The prevalence of LTBI was the highest in HCWs from the Philippines [27.5% ($n = 23$)] and the lowest in HCWs from the Middle East, Saudi Arabia, and Yemen [16.5% ($n = 3$)]. Signs suggestive of inactive TB were found in 10% of the participants ($N = 21$), and all of them were TST positive (44.5% of all TST-positive participants).

**Conclusion** LTBI is prevalent in HCWs in MNH, especially in nurses and in HCWs from countries with high rates of tuberculosis (Philippine and South Asia).

**Keywords:** healthcare workers, latent tuberculosis, Saudi Arabia, tuberculosis

Introduction and aim of the work
According to the WHO, one-third of the world’s population is already infected with TB and every second, someone somewhere is newly infected with tuberculosis [1].

Tuberculosis can be considered both a nosocomial and an occupational infection [2]. TB in healthcare workers (HCWs) is often caused by an infection at their workplace [3]. Adequate infection control measures by the hospital authorities, high suspicion of tuberculosis by clinicians, and early identification of latent tuberculosis infection (LTBI) are necessary to prevent tuberculosis among HCWs [4]. Tuberculin skin test (TST) testing is an accepted inexpensive method for the detection of LTBI despite debates on its limitations and effectiveness in individuals recently vaccinated with BCG [5].

Most published data on LTBI in HCWs in Saudi Arabia were from hospitals of big cities such as Riyadh and Jeddah, and not much data are available for HCWs in remote areas such as Muhayil South of Saudi Arabia.

The aim of this work was to assess the prevalence of LTBI in HCWs in Muhayil, Saudi Arabia.

Materials and methods
This work was carried out in 2013 and included all hired HCWs in Muhayil National Hospital (MNH), Muhayil, south of Saudi Arabia (after obtaining the consent of the participants). Data were collected from each HCW including age, sex, job category, and country of citizenship. They were examined for LTBI using TST by an injection (using a 26-G needle) of 0.1 ml (5 U) of purified protein derivative intracutanously (Mantoux test) into the volar aspect of the forearm. The reaction was read 48–72 h later; the size of the reaction was determined by measurement of the induration, not the erythema. A measurement equal to or more than 10 mm was considered positive [6]. The test was performed and read by the chest consultant in MNH. Plain posteroanterior Chest X Ray (CXR) was also performed for all participants (and if needed sputum stain for Mycobacterium tuberculosis smear) for the detection of active disease. The X rays were examined by the radiology consultant in Muhayil National Hospital (MNH). The study methods were approved by the Muhayil National Hospital ethical committee.

The results of the TST testing and CXR were analyzed with other variables.

Statistical analysis
Statistical analysis was carried out using the SPSS program (version 14; SPSS Inc., Chicago, Illinois,
USA). Odds ratios (ORs) were calculated. All \( P \) values less than 0.05 were considered significant in this study.

**Results**

Of the 208 participants in this work (Table 1), 36 were physicians (32 from the Middle East and four from Yemen), 73 were nurses (54 from Philippines, 11 from South Asia, three from Middle East and five from Yemen), 29 were technicians (10 from Philippines, nine from South Asia, one from Saudi Arabia and nine from Yemen), 39 were administrators (four from Philippines, four from South Asia, seven from the Middle East, and 23 from Saudi Arabia), and 31 were handy workers (15 from Philippines and 16 from South Asia).

The TST was performed for 208 HCWs; 91 (43.75\%) of these workers were men and 117 (56.25\%) were women. Seventy-three (35\%) workers were in the age group 20–29 years, 89 (43\%) workers were in the age group 30–39 years, 27 (13\%) workers were in the age group 40–49 years, and 19 (9\%) workers were in the age group of 50 years or more (Table 2).

TST was positive in 47 (22.5\%) HCWs. The prevalence of positive TST was 22\% (\( n = 20 \)) in men and 23\% (\( n = 23 \)) in women [OR: 1.3; 95\% confidence interval (CI): 0.52, 1.95]. The prevalence of positive TST was 19\% (\( n = 14 \)) in the age group 20–29 years, 23.5\% (\( n = 21 \)) in the age group 30–39 years (OR: 1.3; 95\% CI: 0.4, 4.4), 28.7\% (\( n = 21 \)) in nurses (OR 2; 95\% CI: 0.75, 5.6), 21\% (\( n = 5 \)) in technicians (OR 1.14; 95\% CI: 0.31, 4.2), and 25.8\% (\( n = 7 \)) in workers (OR: 1.9; 95\% CI: 0.58, 6.25) (Tables 3 and 4).

The prevalence of positive TST according to countries of citizenship or region of HCWs was 16.5\% (\( n = 4 \)) in HCWs from Saudi Arabia, 27.5\% (\( n = 23 \)) in HCWs from the Philippines (OR: 1.9; 95\% CI: 0.6, 6.2), 24.4\% (\( n = 10 \)) in HCWs from South Asia (OR: 1.6; 95\% CI: 0.44, 5.85), 16.5\% (\( n = 7 \)) in HCWs from the Middle East (OR: 1; 95\% CI: 0.26, 3.84), and 16.5\% (\( n = 3 \)) in HCWs from Yemen (OR: 1; 95\% CI: 0.19, 5.15) (Tables 3 and 5).

Chest X ray was performed for all participants in this work (\( N = 208 \)) and signs suggestive of inactive TB were found in 10\% (\( N = 21 \)); all of them were TST positive (44.5\% of all TST-positive participants). The overall percent of agreement between positive tuberculin and positive CXR was 87.5\%, the positive percent agreement was 44.7\%, and the negative percent agreement was 100\%. None of the participants had CXR findings suggestive of active TB (thus, no sputum smear examination was performed) (Tables 6 and 7).

### Table 1 Classification of participants according to country (or region) and job category

| Job category | Philippines (N) | South Asia (N) | Middle East (N) | Saudi Arabia (N) | Yemen (N) | Total [N (%)] |
|--------------|-----------------|---------------|----------------|------------------|-----------|--------------|
| Physicians   | 0               | 0             | 32              | 0                | 4         | 36 (17.3)    |
| Nurses       | 54              | 11            | 3               | 0                | 5         | 73 (35)      |
| Technicians  | 10              | 9             | 0               | 1                | 9         | 29 (14)      |
| Administrators | 4           | 5             | 7               | 23               | 0         | 39 (18.7)    |
| Workers      | 15              | 16            | 0               | 0                | 0         | 31 (15)      |
| **Total [N (%)]** | **83 (40.1)** | **41 (19.7)** | **42 (20.2)** | **24 (11.5)** | **18 (8.5)** | **208 (100)** |

*India, Pakistan, and Bangladesh; *Egypt, Sudan, Jordan, Syria, and Palestine.

### Table 2 Tuberculin skin test results according to age and sex of the participants

| Variables       | TST results | \( P \) value | Significance |
|-----------------|-------------|----------------|--------------|
| Positive TST [N (%)] | Negative TST [N (%)] | Total [N (%)] | |
| Age group (years) | | | | |
| 20–29            | 14 (19)         | 59 (81)         | 73 (35)       | 0.000000      | Significant |
| 30–39            | 21 (23.5)       | 68 (76.5)       | 89 (43)       | 0.000000      | Significant |
| 40–49            | 7 (26)          | 20 (74)         | 27 (13)       | 0.000000      | Significant |
| ≥50              | 5 (26.3)        | 14 (73.7)       | 19 (9)        | 0.000000      | Significant |
| **Total**        | 47 (22.5)       | 161 (77.5)      | 208 (100)     | 0.000000      | Significant |

| Sex              | TST results | \( P \) value | Significance |
|------------------|-------------|----------------|--------------|
| Males            | 20 (22)     | 71 (78)        | 91 (43.75)   | 0.000000      | Significant |
| Females          | 27 (23)     | 90 (77)        | 117 (56.25)  | 0.000000      | Significant |
| **Total**        | 47 (22.5)   | 161 (77.5)     | 208 (100)    | 0.000000      | Significant |

TST, tuberculin skin test.
### Table 3 Analysis of risk factors for latent tuberculosis infection in healthcare workers

| Variables | Tuberculin test results* | Odds ratio (95% CI) |
|-----------|-------------------------|----------------------|
|           | Negative (n = 161) [N (%)] | Positive (n = 47) [N (%)] |
| Age group (years) | | |
| 20–29 | 59 (81) | 14 (19) | 1 |
| 30–39 | 121 (76.5) | 42 (23.5) | 1.3 (0.6, 2.78) |
| 40–49 | 20 (74) | 7 (26) | 1.47 (0.52, 4.17) |
| ≥50 | 14 (73.7) | 5 (26.3) | 1.5 (0.46, 4.87) |
| Sex | | |
| Female | 93 (57.8) | 27 (57.4) | 1 |
| Male | 68 (42.2) | 20 (42.6) | 1.01 (0.52, 1.95) |
| Nationality | | |
| Saudi Arabia | 20 (83.5) | 4 (16.6) | 1 |
| Middle East | 35 (83.5) | 7 (16.5) | 1 (0.26, 384) |
| Philippine | 60 (27.5) | 23 (72.5) | 1.9 (0.6, 6.2) |
| South Asia | 31 (75.6) | 10 (24.4) | 1.6 (0.44, 5.85) |
| Yemen | 15 (83.5) | 3 (16.5) | 1 (0.19, 5.15) |
| Occupation | | |
| Administrator | 33 (85) | 6 (15) | 1 |
| Nurse | 52 (71.3) | 21 (28.7) | 2 (0.75, 5.6) |
| Physician | 29 (16.5) | 7 (83.5) | 1.47 (0.52, 4.17) |
| Technician | 24 (21) | 5 (79) | 1.14 (0.31, 4.2) |
| Worker | 23 (74.2) | 8 (25.8) | 1.9 (0.58, 6.25) |

CI, confidence interval; *Tuberculin results of ≥10 are considered positive.

### Discussion

According to the WHO 2014 global TB report [7], there were 9.0 million new TB cases and 1.5 million TB deaths in 2013.

The overall prevalence of LTBI (TST positive) in the participating HCWs was 22.5% (47 out of 208), which is higher than that reported by Abbas et al. [8], who found a prevalence of 11% among HCWs in four major tertiary care hospitals in Riyadh, Saudi Arabia, and higher than that that reported by Nienhaus et al. [9], who found a prevalence of 26.7% (TST, Mantoux method). The prevalence of LTBI was much higher (79%) among HCWs of King Abdulaziz University Hospital, Saudi Arabia [10]. Other studies showed a higher prevalence of LTBI in HCWs (40.8%, 79%) [11,12].

In this work, the prevalence of LTBI in HCWs was the highest in the age groups 40–49 years (26%) and at least 50 years (26.3%) and was the lowest in the age group 20–29 years (19%). Nienhaus et al. [9] reported that the prevalence of LTBI increased from 4.6% in HCW younger than 30 years to 69.2% in HCW older than 60 years. Other studies reported an increased prevalence of LTBI in HCWs with increased age [8,13–15].

### Table 4 Tuberculin skin test results according to job category

| Job category | TST results | | |
|--------------|-------------|-------------------------|---|---|
| | Positive TST [N (%)] | Negative TST [N (%)] | Total [N (%)] | P value | Significance |
| Physicians | 7 (16.5) | 29 (83.5) | 36 (17.3) | 0.000000 | Significant |
| Nurses | 21 (28.7) | 56 (71.3) | 77 (37.3) | 0.000000 | Significant |
| Technicians | 5 (21) | 24 (79) | 29 (14) | 0.000000 | Significant |
| Administrators | 6 (15) | 33 (85) | 39 (18.7) | 0.000000 | Significant |
| Workers | 8 (25.8) | 23 (74.2) | 31 (15) | 0.000000 | Significant |
| Total | 47 (22.5) | 161 (77.5) | 208 (100) | 0.000000 | Significant |

TST, tuberculin skin test.

### Table 5 Tuberculin skin test results according to nationality

| Country or region | TST results | | |
|-------------------|-------------|-------------------------|---|---|
| | Positive TST [N (%)] | Negative TST [N (%)] | Total [N (%)] | P value | Significance |
| Philippine | 23 (27.5) | 60 (72.5) | 83 (40.1) | 0.000000 | Significant |
| South Asiaa | 10 (24.4) | 31 (75.6) | 41 (19.7) | 0.000000 | Significant |
| Middle Eastb | 7 (16.5) | 35 (83.5) | 42 (20.2) | 0.000000 | Significant |
| Saudi Arabia | 4 (16.5) | 20 (83.5) | 24 (11.5) | 0.000000 | Significant |
| Yemen | 3 (16.5) | 15 (83.5) | 18 (8.5) | 0.000000 | Significant |
| Total | 47 (22.5) | 161 (77.5) | 208 (100) | 0.000000 | Significant |

TST, tuberculin skin test; aIndia, Pakistan, and Bangladesh; bEgypt, Sudan, Jordan, Syria, and Palestine.

### Table 6 CXR results compared with tuberculin skin test

| TST results | CXR results | | |
|--------------|-------------|-------------------------|---|---|
| | Positive CXR* [N (%)] | Negative CXR [N (%)] | Total [N (%)] | P value | Significance |
| Positive TST | 21 (44.5) | 26 (55.5) | 47 (100) | 0.000000 | Significant |
| Negative TST | 0 (0) | 161 (100) | 161 (100) | 0.000000 | Significant |
| Total | 21 (10) | 187 (90) | 208 (100) | 0.000000 | Significant |

*Findings suggestive of old TB (e.g. fibronodular lesions, upper zone calcification), NB: none of the participants had signs of active TB.
The prevalence of LTBI was 22% in men and 23% in women, without a significant difference. A similar finding (with lower results of 7.2% in men and 7.1% in women) was reported by Schablon et al. [13]. In another study [16], female HCWs had a higher prevalence of LTBI than male HCWs.

The prevalence of LTBI was the highest among nurses (28.7%) and workers (25.8%) and the lowest among administrators (15%) and physicians (16.5%). Mirtskhulava et al. [16] reported a higher prevalence among nurses and physicians (67.8 and 66.7%). Abbas et al. [8] found that the highest prevalence of LTBI among HCWs was in physicians (14.9%) and nurses (12.9%). In another study [15], the prevalence of LTBI was the highest among physicians (41.2%), followed by nurses (30.3%).

The higher prevalence of LTBI among nurses than among physicians in this work can be attributed to the differences in the burden of TB in their country of citizenship [all participating physicians were from the Middle East and Yemen and most of the participating nurses (65 out of 73) were from South and Southeast Asia (Table 1)].

The highest prevalence of LTBI, according to country or the region of origin in this work, was among HCWs from the Philippine (27.5%). HCWs from South Asia had a prevalence of 24.4%. HCWs from the Middle East, Saudi Arabia, and Yemen had the lowest prevalence (16.5%). Abbas et al. [8] found the highest prevalence among HCWs in Riyadh, Saudi Arabia, from Subsaharan countries (61.1%), followed by HCWs from Western countries (18.7%), and HCWs from East Asian countries (15%). Koshak and Tawfeeq [10] found the highest prevalence among HCWs in Jeddah, Saudi Arabia, in HCWs from Nigeria (87.5%), followed by HCWs from Philippines (83.3%), and HCWs from India and Pakistan (75 and 74.2%).

Higher results were reported by Joshi et al. [17], who studied the prevalence of abnormal radiological findings in HCWs with LTBI and correlations with T-cell immune response in India, and found that LTBI was diagnosed by TST alone in 38% of HCWs (n = 276 out of tested 726 HCW), and 63% of these HCWs had CXR findings suggestive of inactive TB (n = 174).

Kassim et al. [12] studied TST to assess the occupational risk of M. tuberculosis infection among HCWs in Abidjan, Côte D’Ivoire, and reported that out of the 512 participants, 405 (79%) had a TST reaction of at least 10 mm, eight (2%) were anergic, and five (1%) had a radiograph compatible with TB.

**Conclusion and recommendation**

LTBI is prevalent among HCWs in MNH, especially among nurses and HCWs from countries with high rates of tuberculosis (Philippine, India, Pakistan, and Bangladesh). Because HCWs in Saudi Arabia are...
from multiple nationalities and mostly from areas with a high prevalence of TB (South and Southeast Asian countries), pre-employment and postemployment assessment of TB must be considered for better control of TB (especially among HCWs).

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Conflicts of interest
None declared.

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