original article

Latent tuberculosis infection among health-care workers using Quantiferon-TB Gold-Plus in a country with a low burden for tuberculosis: prevalence and risk factors

Abdulellah Almohaya,[a] Abdulwahab Aldrees,[a] Layan Akkielah,[a] Alshaima Talal Hashim,[a] Fahad Almajid,[a] Turki Binmoammar,[b] Mazin A. Barry[a]

From the [a]Infectious Diseases Unit, Department of Internal Medicine, College of Medicine, King Saud University, Riyadh, Saudi Arabia; [b]Occupational Health Unit, Family Medicine Department, College of Medicine, King Saud University, Riyadh, Saudi Arabia

Correspondence: Dr. Abdullelah Almohaya · Infectious Diseases Unit, Department of Internal Medicine, College of Medicine, King Saud University, Riyadh11462, Saudi Arabia · almohayaam@gmail.com · ORCID: https://orcid.org/0000-0003-4532-4626

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BACKGROUND: Health-care workers (HCW) are susceptible to latent tuberculosis infection (LTBI). The prevalence of LTBI in HCW in Saudi Arabia has not been reported using the fourth-generation interferon gamma release assay QuantiFERON-TB Gold Plus (QFT-Plus).

OBJECTIVE: Determine the prevalence of LTBI in a large heterogeneous HCW population and assess risk factors for LTBI.

DESIGN: Cross-sectional and case-control study.

SETTING: Tertiary academic hospital, Riyadh, Saudi Arabia.

PATIENTS AND METHODS: Medical records of HCWs who had QFT-Plus performed between January to December 2018 were reviewed and included in the cross-sectional study. In a subset analysis, randomly selected positive QFT-Plus cases were compared with controls selected from the same areas of work. Univariate and binary logistic regression analyses were performed to assess the significance of other factors to QFT-PLus positivity.

MAIN OUTCOME MEASURES: Prevalence of LTBI in HCWs and potential risk factors for LTBI.

SAMPLE SIZE: 3024 HCWs in the cross-sectional analysis; 294 cases and 294 controls in the case-control analysis.

RESULTS: Twenty-four percent (n=733) of the HCWs had a positive QFT-Plus. The median (interquartile range) age was 34.0 (31.0-37.1) years, 71% were female, and only 24.8% were of Saudi nationals. Nursing represented 57.7% of HCWs, and 24.7% were working in a non-clinical area. Only 20.3% worked in TB-related departments. A higher risk of LTBI was present in HCWs who were older than 50 years (OR=1.95), from either Philippines (OR=4.7) or the Indian subcontinent (OR=4.1), working as a nurse (OR=2.7), allied health profession (OR=2.1), radiology technician (OR=3.1), or in the emergency room (OR=2.4) or intensive care unit (OR=2.1). In the binary logistic regression, independent predictors for positive QFT-Plus were age group older than 50 years (aOR=2.96), known TB exposure (aOR=1.97), and not receiving BCG at birth (aOR=3.08).

LIMITATION: Single-center, retrospective, possible recall bias for BCG vaccination.

CONCLUSION: The high prevalence of LTBI among HCW emphasizes the need to continue pre-employment screening, especially for employed personnel from high endemic areas, with targeted annual

screening for the same group and other identified high-risk groups. These findings can aid in the development of national screening guidelines for LTBI in HCW.

CONFLICT OF INTEREST: None.

Globally, more than 10 million people developed tuberculosis (TB) in 2018.[1] Efforts to end the TB epidemic by the year 2030 are not progressing towards milestone goals for various reasons.[1] Screening and treatment of people with latent TB infection (LTBI) is part of the current health care intervention for TB prevention.[1] LTBI is a state of a persistent immune response to stimulation by *Mycobacterium tuberculosis* antigens but with no clinically manifested active TB. The TB notification rate among HCWs relative to the general adult population has been used as a ratio indicator for prevention of TB infection because HCWs have an increased risk of acquiring TB and are among the high-risk populations for LTBI screening by WHO.[1-3] More recent CDC guidelines still recommend screening for LTBI upon employment for all HCW. However, as of May 2020, national guidelines and evidence-based recommendations for LTBI in HCW are still lacking in Saudi Arabia.

The diagnosis of LTBI can be established using either the tuberculin skin test (TST) or the interferon gamma release assay (IGRA). An advantage of IGRA is that it is not affected by bacillus Calmette-Gūerin (BCG) vaccination nor by non-tuberculous mycobacterial infections, and does not need to be read at 48-72 hours. IGRA is also not dependent on the method of injection (the Mantoux or purified protein derivative test) and does not involve interpretation of induration size. In addition to the difference in the risk of TB exposure between different screened populations in the literature, the variety of LTBI diagnostic tools results in a large discrepancy in LTBI prevalence among studies, as conversion rates with IGRA are much higher than with TST, and there are cases of reversions and poor reproducibility.[5] In a meta-analysis that evaluated the test agreement between the conventional TST to different generations of QFT (but not QFT-PLUS), the Cohen's κ coefficient ranged between 0.19 and 0.38.[6]

The most recent generation of IGRA tests is the fourth-generation QuantiFERON-TB Gold-Plus (QFT-Plus). Until the present report, the exact test agreement between the QFT-Plus and the conventional TST had not been established in the literature. In one study, the newer QFT-Plus showed slightly higher positivity in TST-positive individuals when compared to the older generation QuantiFERON-TB Gold In-Tube (QFT-GIT) test.[7] Since its introduction in 2015, QFT-Plus has been implemented in many hospitals in the world. QFT-Plus has two tubes (TB1 and TB2) with peptides of *Mycobacterium tuberculosis* complex antigens ESAT-6 and CFP-10. TB1 detects the IFN-γ response from CD4+ helper T lymphocytes, while TB2 detects the same response from CD8+ cytotoxic T lymphocytes; a CD8+ response is more commonly the result of active TB or more recent acquisition of infection.[8] A reaction from either tube is considered positive. Although studies have shown comparable results between QFT-Plus and previous generations of QFT, implementation in low TB-incidence countries is still questionable.[9]

Saudi Arabia is categorized as having a low cumulative incidence of TB of 10 (8.7–12) per 100 000 population[1] with an annual incidence over a 20-year period of 13 to 17 per 100 000 population.[10] Based on epidemiological studies,[11] the estimate is not more than 9.3%, which is much lower than the average estimates for the world's general population (23%).[12] In HCWs, the pooled prevalence of LTBI is reported to be around 14.1% from low-TB incidence countries when QFT-GIT is used.[4] However, LTBI prevalence in HCWs in Saudi Arabia varied widely between studies using the QFT-GIT diagnostic method (10.8%[13] and 25%[14]). The prevalence in Saudi Arabia has never been studied using QFT-Plus.

Almost a third of HCWs in Saudi Arabia are not native Saudi nationals.[15] Many are from countries with a high TB incidence, especially India, with an incidence of 199 per 100 000 population and the Philippines with an incidence of 554 per 100 000 population. In our institution, evaluation for LTBI is required upon employment, and more recently, a new policy for annual screening of LTBI was implemented by the infection prevention and control department. We aimed to determine the prevalence of LTBI among HCWs using QFT-Plus and to assess risk factors for LTBI.

PATIENTS AND METHODS

Study design and population

This prevalence and case-control study was carried out in the tertiary academic hospital in King Saud University Medical City, Riyadh, Saudi Arabia, between 1 January

and 31 December 2018. All HCWs underwent QFT-Plus testing as part of a new infection prevention and control policy. Inclusion criteria were being a HCW who was tested for QFT-Plus in the employee clinic at any given time during the study period. All employees who began working during that period were included as participants in the analysis. Employees with active TB disease were excluded (**Figure 1**).

To further assess possible risk factors for LTBI, HCWs with LTBI (LTBI-HCW group) were compared to a control group based on their area of work. Cases in the LTBI-HCW group and in the control group were selected randomly using random number generation for each case. The required number of cases in each group was calculated based on previous studies in which the prevalence of LTBI in HCW In Saudi Arabia was between 10-25%.[13,14] An estimated minimum sample of 294 subjects in each group was calculated based on the level of confidence measure of 1.96, margin of error (MOE) of 0.05, estimated prevalence of 15%, and a design effect of 1.5. Data collection was carried out by the authors, and included information on demography, medical history, smoking status, TB exposure, job category, area of work category, history of previous TST, QFT-Plus results, and work years in a hospital setting. Data were collected from the health care system or, if needed, through direct communication using a questionnaire or phone interview. The study was approved by the King Saud University's institutional review board (reference 19/0284/IRB) and informed consent was given by all study participants.

Definitions

Jobs were categorized into physicians, nurses, laboratory technicians, radiology technicians, allied health professions, and non-clinical jobs. Work areas were categorized into TB-related areas: intensive care unit (ICU), emergency department (ER), isolation wards, and microbiology laboratory; and TB-unrelated areas: outpatient-clinics, general wards, other clinical areas, general laboratories, and non-clinical areas. TB exposure was divided into occupational exposure (in which the exposure happened within a health care facility) or household exposure. BCG vaccination was counted either by patient history or by the vaccination policy of the country of birth. Detailed definitions can be found in the appendix.

LTBI evaluation

According to manufacturer's recommendations, interferon gamma release assay (IGRA) was run using four tubes of whole blood (QuantiFERON-TB Gold Plus, Qiagen, Hiden, Germany) to measure responses to ESAT-6 and CFP-10 peptide antigens. A positive test was considered when either the TB1 or TB2 tubes of the 4 tubes (Nil, TB1, TB2, Mitogen) was above the nil IFN-γ IU/mL value. Clinical and radiological evaluation was performed by the physician of the occupational health care clinic by evaluating any symptoms, signs, and chest X-ray. Subjects were considered as having LTBI if found to have a reactive QFT-Plus without clinical or radiological evidence of active TB disease.

Statistical analysis

Prevalence was calculated by dividing the number of positive QFT-Plus by the total number of screened HCWs. Statistical analysis was carried out by using the SPSS software (version 23, IBM Corp., Armonk, N.Y., USA). A chi-squared test was used and all variables were subjected to calculate the odds ratio and 95% confidence interval. Further data analysis to explore possible multivariable associations was carried out using binary logistic regression analysis.

RESULTS

Prevalence

Between 1 January 31 and December 31 2018, 3024 HCWs underwent QFT-Plus testing. The median (in-

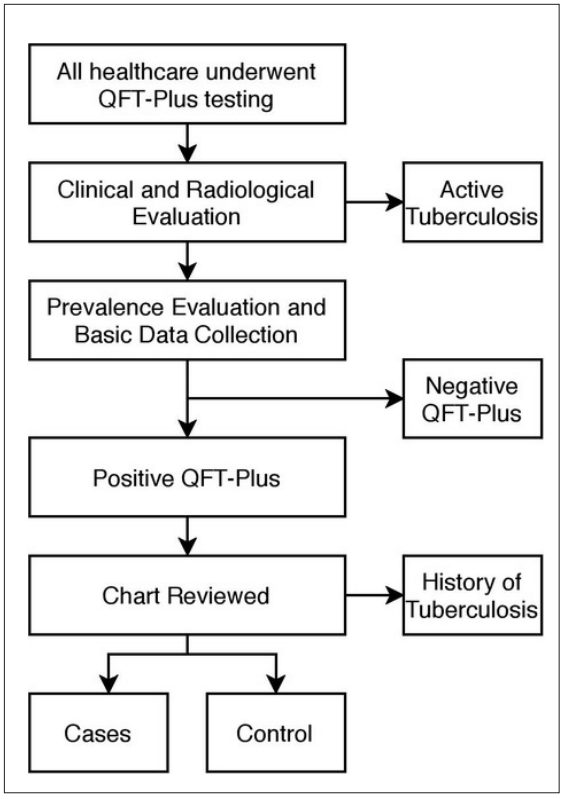

Figure 1. Study flow diagram.

Table 1. Demographic, occupational, and diagnostic characteristics among all screened HCWs.

	All patients (n=3024)	QFT-plus result		*P* value	Odds ratio (95% CI)
		Positive n=733 (24.2)	Negative n=2291 (75.8)		
Age groups in years (median=34 years)					
Less than 30 years	683 (22.6)	142 (20.8)	541 (79.2)	<.001	Ref (1)
31-40 years	1438 (47.6)	310 (21.6)	1128 (78.4)		1.047 (0.837-1.309)
41-50 years	616 (20.4)	184 (29.9)	432 (70.1)		1.623 (1.26-2.09)
Above 50 years	287 (9.5)	97 (33.8)	190 (66.2)		1.945 (1.432-2.643)
Gender					
Female	2149 (71.1)	571 (26.6)	1578 (73.4)	<.001	1.593 (1.310-1.937)
Male	875 (28.9)	162 (18.5)	713 (81.5)		Ref (1)
Nationality					
Saudi	750 (24.8)	67 (8.9)	683 (91.1)	<.001	Ref (1)
Indian subcontinent	722 (23.9)	208 (28.8)	514 (71.2)		4.125 (3.062-5.558)
Philippines	1341 (44.3)	423 (31.5)	918 (68.5)		4.697 (3.564-6.191)
Other nationals	211 (7)	35 (16.6)	176 (83.4)		2.027 (1.304-3.151)
Job category					
Physician	123 (4.1)	18 (14.6)	105 (85.4)	<.001	1.1 (0.64-1.88)
Nurse	1745 (57.7)	514 (29.5)	1231 (70.5)		2.67 (2.11-3.37)
Allied health	318 (10.5)	78 (24.5)	240 (75.5)		2.08 (1.49-2.89)
Laboratory tech	49 (1.6)	8 (16.3)	41 (83.7)		1.25 (0.57-2.24)
Radiology tech	43 (1.4)	14 (32.6)	29 (67.4)		3.08 (1.58-6.03)
Non-clinical	746 (24.7)	101 (13.5)	645 (86.5)		Ref (1)
Area risk					
TB-unrelated areas	2411 (79.7)	569 (23.6)	1842 (76.4)	.104	Ref(1)
TB-related areas	613 (20.3)	164 (26.8)	449 (73.2)		1.182 (0.966-1.447)
Area					
Emergency room	228 (7.5)	66 (28.9)	162 (71.1)	<.001	2.415 (1.703-3.425)
Intensive care unit	364 (12)	95 (26.1)	269 (73.9)		2.094 (1.539-2.849)
Isolation wards	16 (0.5)	2 (12.5)	14 (87.5)		0.847 (0.19-3.777)
Microbiology lab	5 (0.2)	1 (20)	4 (80)		1.482 (0.16-13.38)
Outpatient clinics	429 (14.2)	99 (23.1)	330 (76.9)		1.779 (1.316-2.403)
General wards	778 (25.7)	268 (34.4)	510 (65.6)		3.115 (2.429-3.996)
Other clinical areas	382 (12.6)	80 (20.9)	302 (79.1)		1.57 (1.143-2.157)
General laboratory	46 (1.5)	10 (21.7)	36 (78.3)		1.647 (0.795-3.413)
Non-clinical areas	776 (25.7)	112 (14.4)	664 (85.6)		Ref (1)

Data are number (%). QFT: QuantiFERON. Indian subcontinent countries: Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

terquartile range) age was 34.0 (31.0-37.1) years with almost half (47.6%) between 31-40 years of age (**Table 1**). Seventy-one percent were female (n=2149). The highest proportion by nationality was Filipino (n=1341, 44.3%), while 24.8% of subjects were Saudi nationals (n=750). Nursing constituted 57.7% (n=1745) of the HCW jobs, 90% of whom were female. People who worked in non-clinical jobs represented 24.7% (n=776); the majority in non-clinical jobs were of Saudi nationality (71.2%, n=531). Only 20.3% worked in TB-related departments (n=616). A positive QFT-Plus and a diagnosis of LTBI was associated with age older than 50 years (OR=1.945, 95%CI: 1.432-2.643), female gender (OR=1.593, 95%CI: 1.310-1.937), nationality ($P \leq .001$), job category ($P \leq .001$), and working in ER (OR=2.415, 95%CI: 1.703-3.425), ICU (OR=2.094, 95%CI: 1.539-2.849). (**Table 1, Figure 2 and 3**).

Of the 3024, 733 HCWs (24.2%) had a positive QFT-Plus. None of the QFT-Plus positive HCWs had symptoms suggestive of active TB and therefore all were labeled as LTBI. Chest radiographs were performed for all HCWs who were IGRA positive except for 6 cases (0.8%). Only 3 HCWs (0.4%) underwent chest computed tomography scans for the evaluation of abnormal chest radiographs; two had normal results. Of the QFT-Plus positive cases, a history of a previous negative tuberculin skin test was found in 365/738 (49.8%) with a median interval of 4 years (range: 1-35 years) between the two tests (**Table 2**).

Case-control analysis

In the comparison of the LTBI-HCW group with the control group, statistically significant associations with LTBI were found for the age group above 50-years-old (OR=2.79, 95%CI: 1.49-5.23), for known TB exposure (OR=1.9, 95%CI: 1.37-2.65), and for not receiving BCG at birth (OR=3.13, 95%CI: 1.22-8.05) (**Table 3**). Age less than 50 years old, gender, smoking, nationality, prior history of comorbid conditions, travel to high TB burden countries, category of job, risk area, type of exposure, career duration, length of career in King Khalid University Hospital, length of career in Saudi Arabia and length of career outside Saudi Arabia were not signifi-

Table 2. Results of the imaging and previous tuberculin skin tests for all healthcare workers with positive interferon gamma release assay (QuantiFERON-TB Gold Plus), (n=733):

Investigation	Number (%)
Chest x-ray	
Normal	711 (97)
Abnormal	16 (2.2)
Not done	6 (0.8)
TST to QFT	
History of negative TST	365 (49.8)
Both positive	89 (12.1)
No previous TST	279 (38.1)

QFT: QuantiFERON. TST: Tuberculin Skin Test.

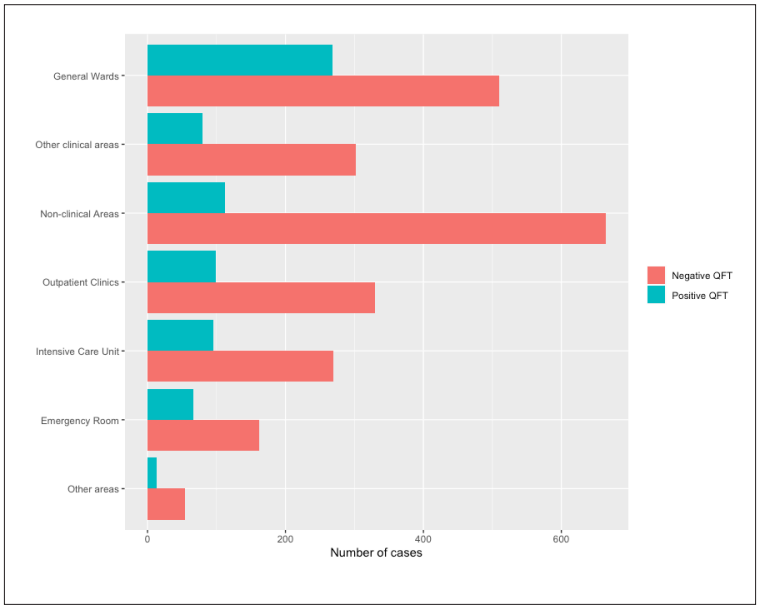

Figure 2. QFT-Plus results by area of work.

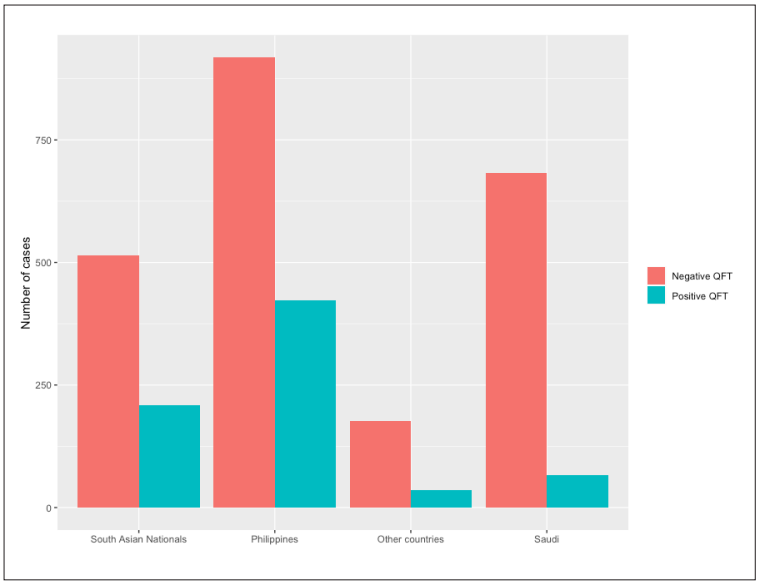

Figure 3. QFT-Plus results by region of origin.

Table 3. Univariate asscociation of sociodemographic and clinical characteristics between cases with latent tuberculosis and controls.

Characteristics	LTBI-HCW (n=294)	Controls (n=294)	*P* value	OR (95% CI)
Age groups in years (median 35 years)				
≤30	53 (44.5)	66 (55.5)		1.0 (ref)
31-40	126 (46.7)	144 (53.3)	.005	1.09 (0.71, 1.68)
41-50	68 (51.9)	63 (48.1)		1.34 (0.82, 2.21)
>50	47 (69.1)	21(30.9)		2.79 (1.49, 5.23)
Gender				
Male	64 (53.3)	56 (46.7)	.413	1.18 (0.79, 1.77)
Female	230 (49.1)	238 (50.9)		1.0 (ref)
Smoking				
Smoker	15 (53.6)	13 (46.4)		1.54 (0.49, 4.81)
Ex-smoker	9 (42.9)	12 (57.1)	.751	1.0 (ref)
Non-smoker	270 (50.1)	269 (49.9)		1.34 (0.55, 3.23)
Nationality				
Saudi	25 (37.3)	42 (62.7)		1.0 (ref)
Indian subcontinent	97 (48.3)	104 (51.7)	.079	1.57 (0.89, 2.76)
Philippine	155 (54.4)	130 (45.6)		2.0 (1.16, 3.46)
Other countries	17 (48.6)	18 (51.4)		1.59 (0.69, 3.63)
Travel to countries with high TB burden*				
Yes	250 (50.1)	249 (49.9)	.908	1.03 (0.65, 1.61)
No	44 (49.4)	45 (50.6)		1.0 (ref)
Category of job				
Physician	12 (50)	12 (50)		1.19 (0.47, 3.03)
Nurse	207 (49.1)	215 (50.9)		1.15 (0.69, 1.92)
Lab/Radiology tech	5 (45.5)	6 (54.5)	.362	0.99 (0.28, 3.57)
Allied health	39 (61.9)	24 (38.1)		1.94 (0.97, 3.89)
Non-clinical jobs	31 (45.6)	37 (54.4)		1.0 (ref)
Area risk				
High	87 (50)	87 (50)	1.00	1.0 (0.70,1.42)
Low	207 (50)	207 (50)		1.0 (ref)
Known TB exposure				
Yes	164 (58.4)	117 (41.6)		1.91 (1.37, 2.65)
Average time since exposure (y)	7	6	<.0001	
No	130 (42.3)	177 (57.7)		1.0 (ref)

Table 3 (cont.). Association of sociodemographic and clinical characteristics between health care workers with latent tuberculosis and controls.

Characteristics	LTBI-HCW (n=294)	Controls (n=294)	*P* value	OR (95% CI)
Type of exposure				
Occupational	146 (57.3)	109 (42.7)	.238	1.0 (ref)
Non-occupational	18 (69.2)	8 (30.8)		1.68 (0.70,4.0)
Career duration				
≤5 years	54 (44.3)	68 (55.7)	.155	1.0 (ref)
>5 years	240 (51.5)	226(48.5)		1.34 (0.89,2.0)
Career in our institute (median=6 years)				
≤5 years	138 (49.3)	142 (50.7)	.741	1.0 (ref)
>5 years	156 (50.6)	152 (49.4)		1.06 (0.76,1.46)
Time in Saudi Arabia (median 7 years)				
≤ 5 years	105 (48.4)	112 (51.6)	.550	1.0 (ref)
>5 years	189 (50.9)	182 (49.1)		1.11 (0.79,1.55)
Time outside Saudi Arabia (median 9 years)				
≤5 years	249(49.2)	257 (50.8)	.341	1.0 (ref)
>5 years	45 (54.9)	37 (45.1)		1.25 (0.78,2.01)
BCG at birth				
Yes	276 (48.9)	288 (51.1)	.012	1.0 (ref)
No	18 (75)	6 (25)		3.13 (1.22,8.0)
Medical history				
Yes	82 (45.8)	97 (54,2)	.105	0.78 (0.55,1.12)
No	212 (51.8)	197 (48.2)		1.0 (ref)

OR: Odds ratio. CI: Confidence Interval. TB: Tuberculosis. BCG: bacille Calmette-Guerin. Indian subcontinent countries: Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. List of countries is available in the appendix.

Table 4. Independent risk factors associated with latent tuberculosis infections in health care workers (case-control population) by stepwise multivariate binary logistic regression.

Characteristics	Coefficient (B)	Standard error	Wald X^2	*P* value	aOR (95% CI)
Age 31-40 years	.142	.225	.399	.528	1.15 (0.74,1.79)
Age 41-50 years	.364	.260	1.959	.162	1.44 (0.87,2.39)
Age >50 years	1.086	.327	11.042	.001	2.96 (1.56,5.62)
Known TB exposure	.679	.171	15.782	<.001	1.97 (1.41,2.76)
No BCG at birth	1.126	.490	5.282	.022	3.08 (1.18,8.05)

Model fit measures: Deviance 780.023, Cox and Snell R square 0.058, Nagelkerke R square 0.077. aOR: Adjusted odds ratio. CI: Confidence Interval. TB: Tuberculosis. BCG: bacille Calmette-Guerin. Age categories are referenced to those of age 30 years and younger.

cantly associated with LTBI. The multivariate binary logistic regression analysis showed that age groups (older than 50 years), known TB exposure (Yes), and BCG at birth (No) were highly independently associated with LTBI (**Table 4**).

DISCUSSION

Compared to other studies within the region, this study included the largest number of HCWs for screened LTBI as of May 2020. The use of the newly introduced generation of IGRA (QFT-Plus) and the case-control methodology to identify additional risk factors are also unique. The first aim of this study was to explore the prevalence of LTBI in the population of HCWs in our institute. Although only 20% of participants worked in TB-related departments, 24% (n=733) of HCWs (including those with non-clinical jobs) had a positive QFT-Plus. High-risk areas were not associated with LTBI, as their prevalence was 26.8% compared to 23.6% in non-TB related work areas. However, the subset analysis did show a higher risk of LTBI for HCW in ICU and ER where the flow of active TB patients are often first encountered before diagnosis and proper initiation of airborne infection isolation. Unexpectedly, working in the microbiology laboratory or isolation wards was not associated with a diagnosis of LTBI, probably due to the overall small sample size of only 21 HCW from both areas and to routine adherence to infection control policies in these high risk areas.

The overall prevalence in our study is similar to that from a previous study conducted at another institute in Saudi Arabia (25%).[14] Yet, it is impractical to compare the two studies as they used different testing methods (QFT-GIT was used in the other study). The prevalence in both hospitals was much higher than the estimated prevalence of LTBI in the general population (9.3%).[11] This high prevalence may be due to the heterogeneous population in our health care facilities, which uniquely recruits most of their HCW from high endemic countries like India and the Philippines that have been identified in our study and other studies to have a much higher likelihood of being diagnosed with LTBI. This may also be one of the weak points in TB management in Saudi Arabia. When analyzing only the population of Saudi HCWs, the prevalence was similar to the general population (8.9% vs. 9.3%, respectively). Another reason for the relatively high prevalence may be that the threshold for the positive QFT-Plus test in our center (i.e., a test was considered positive when either TB1 or TB2 is positive, not both) may play a role in greater positivity. Many studies use a more conservative approach (both TB1 and TB2 tubes must be positive instead of only one).[16] In addition, high positivity rates were reported in North American hospitals upon first approval of the first IGRA test in 2005, which resulted in calls to increase cutoff values for QFT-Plus test.[17]

The second aim of this study was to explore predictors for positive QFT-Plus in a case-control manner. Since previous studies have identified the area of work as a predictor,[18] we chose to explore other variables that might affect LTBI infection with HCWs in the same area of work. Age is always reported as a risk factor for positive LTBI tests. Our case-control findings were similar to a previous multicenter study in Saudi Arabia that reported that age older than 50 years is significantly associated with LTBI.[19] It is still unclear whether the relationship is related to age or to time spent as a health care practitioner, but this may have implications for targeted screening of age groups in the future. History of exposure to TB was also significantly associated with LTBI in our cases compared to the control subjects. Although obvious, this signifies the reliability of a reported history of TB exposure by HCWs and supports targeted testing of exposed staff.

In keeping with previous studies that used other QFT generations in BCG-vaccinated populations, we found BCG non-vaccinated cases were more likely to have positive QFT-Plus. There is probably a risk of recall bias as BCG is typically given at birth. Further evaluation for documented BCG vaccination would be more reliable. However, a similar finding was reported in a previous study where people with a BCG vaccination history had a low OR for positive QFT-3-G.[20]

Job category is usually reported as being significantly associated with LTBI acquisition, namely physicians,[13,19] nurses,[19] or radiology technicians.[21] We found that nurses, allied health, and radiology technicians had a greater LTBI risk compared with jobs in non-clinical settings. In addition to previously reported poor adherence to infection control policies among all HCWs, radiology technicians are presumed to be at a higher risk of acquiring LTBI due to close contact to patients with pulmonary TB while performing chest radiographs.

In conclusion, the higher prevalence of LTBI amongst HCW emphasizes the need to continue pre-employment screening and management, especially for hired personnel coming from high endemic areas, with possibly targeted annual screening by QFT-Plus for the same group and other identified high-risk groups, especially those older than 50 years of age and those having a known TB exposure, as well as certain job categories like nurses, allied health person-

nel, and radiology technicians, and those working in the ICU and ER. A limitation of the study is that it was conducted in a single center. The results of this study need to be validated in similar centers to help aid in developing national guidelines for LTBI screening and management in HCW.

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