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Tuberculin skin test evaluation in healthcare workers and distribution by occupation

Sami Deniz, Jülide Çeldir Emre[1]

Abstract:

OBJECTIVE: Tuberculosis (TB) is a potential occupational threat for healthcare workers (HCWs) worldwide. We aimed to evaluate the tuberculin skin test (TST) and investigated if there was any difference between occupations.

METHODS: This was designed as a prospective study. The analysis was performed on 331 participants. Purified protein derivative was administered to all cases. In addition, cases' age, gender, and smoking status were questioned and their comorbidities were recorded. Both shoulder areas were checked, and the Bacille Calmette-Guérin (BCG) scar counts were recorded.

RESULTS: Out of a total of 331 participants, 207 were female and 124 were male; mean age was 39 ± 8 (min; 18, max; 61) and TST was 12 ± 6 mm. The cases were categorized by considering participants' exposure to TB (Group-1 - Doctor; Group-2 - Midwife-Nurse-Health Technician-Laboratorian; Group-3 - Technician-Administrative Staff; Group-4 - Secretary-Auxilliary Staff; and Group-5 - Security, Cleaning, Cafeteria Staff). When compared in terms of TST, there was a statistically significant difference ($P < 0.001$). The cases had at least 1 and maximum 3 BCG scars. Based on this, three groups were formed. Two hundred and twenty-three cases had 2 scars, 58 had 1, and 41 had 3. Significant difference was found among three groups, and similarly, there was a statistically significant difference in paired comparisons ($P < 0.001$; for all comparisons). While the difference was detected in the group with two BCG scars, there was no difference in other groups ($P = 0.7$, 0.001, and 0.5, respectively). There was a significant difference in terms of TST between genders ($P < 0.001$).

CONCLUSION: Exposure to TB may vary according to professions, but the socioeconomic situation cannot be determined by professions.

Keywords:

Healthcare workers, tuberculin skin test, tuberculosis

Department of Chest Diseases, SBU İzmir Dr. Suat Seren Chest Diseases and Thoracic Surgery Research and Educational Hospital, İzmir, [1]Department of Chest Diseases, Turgutlu State Hospital, Manisa, Turkey

Address for correspondence:
Dr. Sami Deniz, SBU İzmir Dr. Suat Seren Chest Diseases and Thoracic Surgery Research and Educational Hospital, İzmir, Türkiye.
E-mail: sami_deniz@yahoo.com

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Introduction

Tuberculosis (TB) is a potential occupational threat for healthcare workers (HCWs) worldwide. Among HCWs from low- and middle-income countries, latent TB infection (LTBI) was consistently associated with markers of occupational exposure.[1] A meta-analysis published recently reported that the pooled prevalence estimate for LTBI among HCWs was 37% (95% confidence interval [CI], 28%, 47%), with six studies reporting the prevalence of >50%, even though estimates ranged from 0.5% to 62%.[2] In a study which has investigated the frequency of LTBI in HCWs, 469 cases were screened and 129 HCWs had a positive Interferon-Gamma Release Assays (IGRAs). In another study, it was detected to be the tuberculin skin test (TST) reactive of 122 HCWs (31%) (induration >5 mm), at a previous screening in the past.[3] A study which was investigated in the detection of

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LTBI among HCWs agreement between TST and IGRA were reported to be poor.[4]

Occupational health programs have a choice between newer IGRAs and the TST in HCWs. Guidelines of the Centers for Disease Control and Prevention show that IGRA or a TST may be used without preference in surveillance programs for HCWs.[5] Some healthcare systems routinely test their employees using IGRAs, whereas others have continued to use TST for LTBI screening among their employees. There is good evidence that both tests are acceptable, but imperfect tests for LTBI.[6] According to our national guidelines for LTBI screening, it is recommended that IGRAs should be performed in those who are TST-negative (with booster) and immunosuppressed or immunosuppressive treatment candidates who are strongly considered as TB infections. TST should be continued in our country.[7]

We aimed to evaluate the TST results in HCWs and investigate if there was a difference between occupation.

Methods

A total of 1131 employees working in six different public hospitals were evaluated. It was designed as a prospective study. Participants who did not give consent and meet exclusion criteria were excluded; the analysis was performed on the remaining 331 patients. Ethics committee approval was obtained, and the participants were informed through informed consent forms. The participants were informed regarding why the TST test is performed and about the procedures. Participants who met the following criteria were excluded from the study.

Exclusion criteria

Individuals who did not consent, administered TST recently, underwent TB in the past or had suspicion of TB, lived in the same house with a TB patient recently, diagnosed with cancer and/or were currently receiving therapy, with autoimmune and immunosuppresive diseases were excluded from the study.

Test procedure

The forearm was held with palm being in upward position, and the test site was determined. An area distant from wounds, scratch, veins, hairs, and muscle edges with a 5–10 cm distance from the elbow joint was determined. A volume of 0.1 ml solution containing purified-protein derivative was administered in the subcutaneous area. When a pale area of 6–10 cm was formed, the administration was considered to be performed properly. In patients with swelling <6 cm, the test was repeated using a similar method in an area 5 cm distant from the test site. The patients was informed that he/she should avoid itching the area, keep the area clean and avoid cream, lotion, and dressing.

Test evaluation

48–72 h after the test was performed and the presence of induration was checked. On visual inspection, only induration in stiff, dense, and swollen form was measured. If induration was not visible, it was determined by palpation. Induration margins were sensitively checked in a lit environment, and the largest diameter was marked. It was measured with a plastic flexible millimeter ruler. If no induration was present, it was recorded as "0," if present; the value was recorded in mm.

In addition, cases' age, gender, and smoking status were questioned. Their comorbidities were recorded. Both shoulder areas were checked, and the Bacille Calmette-Guérin (BCG) scar counts were recorded.

Statistical analysis

In this study, statistical analyses were performed in Statistical Package for Social Sciences (SPSS) program V22 (IBM Corp, Armonk, New York), For all comparisons, Type 1 margin of error was designated as 0.05, and two-sided tests were performed. For the comparisons of categorical variables, Chi-square test methods were used. The Kruskal–Wallis test was used to compare multiple groups, and the Mann–Whitney U-test was used comparisons of pairwise continuous variables. In all statistical methods, Type 1 error coefficient was determined as $\alpha = 0.05$. In cases in which $P < 0.05$, the intergroup difference was considered to be statistically significant.

Results

Out of a total of 331 participants, 207 were female, 124 were male; mean age was 39 ± 8 (min; 18, max; 61). An average number of BCG scars were 2; mean TST was found to be 12 ± 6 mm. Of all cases, 136 were currently smoking, 31 quit smoking, and the rest did not smoke. A total of 30 cases had comorbidities. The most common comorbidity was hypertension, being present in 21 cases.

The cases were categorized based on their occupations by considering participants' exposure to TB (Group-1 - Doctor; Group-2 - Midwife-Nurse- Health Technician-Laboratorian; Group-3 - Technician-Administrative Staff; Group-4 - Secretary-Auxilliary Staff; Group-5 - Security, Cleaning, Cafeteria Staff). When age, gender, BCG scar count, and TST distribution was checked based on occupational groups, significant differences were detected ($P < 0.05$). No differences were detected in terms of smoking and comorbidity ($P = 0.519, 0.514$) [Table 1].

Table 1: Distribution of demographic data, smoking, comorbidity, tuberculin skin test, and Bacille Calmette-Guérin scar count according to occupational groups

Variables	1 (15, 4.5%)	2 (87, 26.3%)	3 (35, 10.6%)	4 (71, 21.5%)	5 (123, 37.2%)	Total	P
Age							
Mean±SD	45.9±9.7	40.5±7.9	38.4±7.8	35±7.5	39.7±6.8		<0.001
Med (minimum, maximum)	49 (33, 61)	40 (20, 56)	38.5 (23, 56)	34 (16, 58)	41 (25, 55)		
TST							
Mean±SD	8.8±4.8	11.9±5	10.8±6.1	9.9±6.5	14.4±6		<0.001
Med (minimum, maximum)	9 (0, 16)	12 (0, 25)	10 (0, 25)	10 (0, 30)	15 (0, 35)		
Gender							
Female	4 (1.9)	83 (39.9)	17 (8.2)	55 (26.4)	49 (23.6)	208	<0.001
Male	11 (8.9)	4 (3.3)	18 (14.6)	16 (13)	74 (60.2)	123	
Smoking							
Never smoker	7 (4.3)	37 (23)	17 (10.6)	40 (24.8)	60 (37.3)	161	0.519
Smoker and exsmoker	8 (4.8)	50 (29.9)	15 (9)	31 (18.6)	63 (37.7)	167	
Comorbidity							
Yes	4 (10)	10 (25)	4 (10)	7 (17.5)	15 (37.5)	40	0.514
No	11 (3.8)	77 (26.5)	31 (10.7)	64 (22)	108 (37.1)	291	
BCG scar count							
1	6 (10.3)	14 (24.1)	9 (15.5)	15 (25.9)	14 (24.1)	58	0.017
2	9 (4)	58 (26)	20 (9)	46 (20.6)	90 (40.4)	223	
3	0	15 (36.6)	4 (9.8)	6 (14.6)	16 (39)	41	

SD: Standard deviation, BCG: Bacille Calmette-Guérin, TST: Tuberculin skin test

When the occupational groups were evaluated based on the number of BCG scars there was a statistically significant difference between them (P = 0.017). In paired comparison, statistically significant difference was detected between Group 1 and 2 (P = 0.012) and between Group 1 and 5 (P = 0.03).

When the groups were compared in terms of TST, there was a statistically significant difference (P < 0.001). In paired comparisons, it was detected to be significance between Group 1 and 2 (P = 0.039), Group 1 and 5 (P < 0.001), Group 2 and 4 (P = 0.03), Group 2 and 5 (P = 0.001), Group 3 and 5 (P = 0.001), and Group 4 and 5 (P < 0.001) [Figure 1].

The cases had at least 1 and maximum 3 BCG scars. Based on this, three groups were formed. 223 patients had 2 scars, 58 patients had 1, and 41 patients had 3. Significant difference was found when three groups were compared, and similarly, there was a statistically significant difference in paired comparisons (P < 0.001; for all comparisons) [Figure 2].

There was a significant difference in terms of TST between genders (P < 0.001). BCG scars were compared as 1, 2, and 3 between genders. While the difference was detected in the group with two scars, there was no difference in other groups (P = 0.7, 0.001, and 0.5, respectively) [Figure 3].

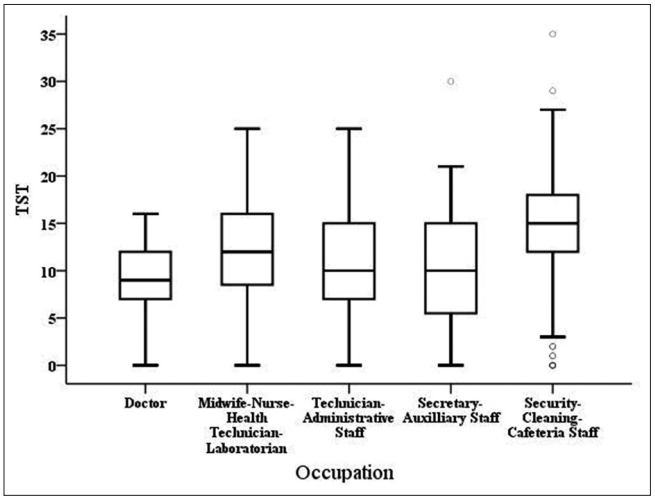

Figure 1: Tuberculin skin test comparison among the occupational groups

Discussion

In recent years, TB cases in the general population and HCWs have increased.[8] Participation rate to this study which was performed to define the TST sensitivities and obtain baseline values for our staff was low. This may be because hospital staff is not adequately informed about the risk of TB infection and ignore the risk. The hospital risk should be determined by repeating checks in HCWs at certain intervals as a serial annual follow-up, and the necessary data to take measures should be obtained.

BCG vaccine rate was 100% in our staff. The proportion of vaccinated individuals in our country is 73%–94% in several studies.[8,9] Vaccination rate in our staff appears to be quite high. The fact that mean age in the study was young and the HCWs were working in a hospital in the developed province, Aydın, on the west side of the country, and successful in vaccination and fight against

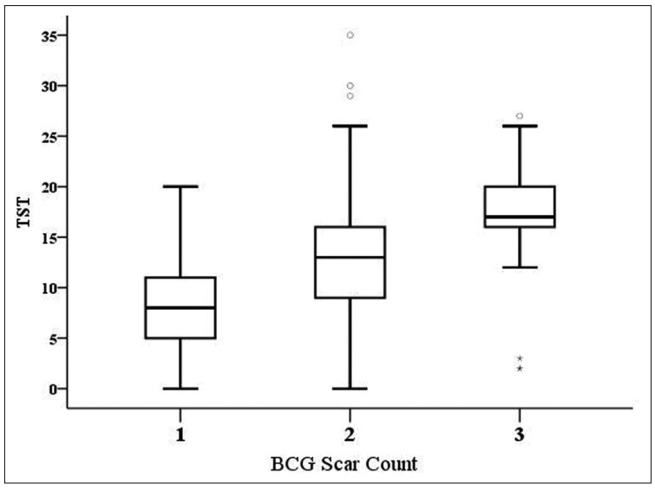

Figure 2: The relationship between tuberculin skin test values and the number Bacille Calmette-Guérin scars

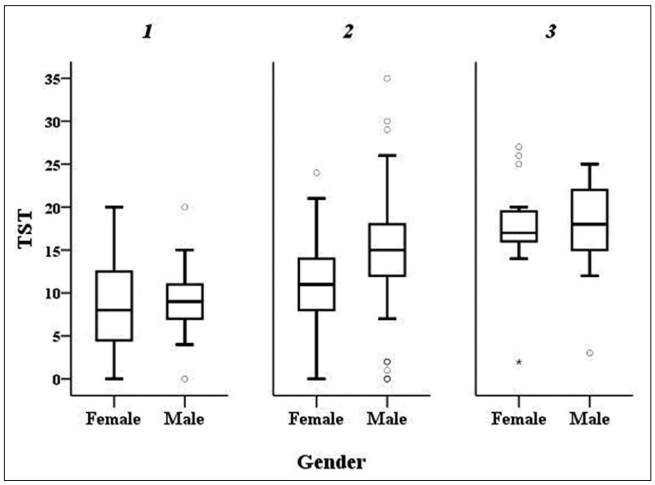

Figure 3: The comparison of tuberculin skin test between genders based on Bacille Calmette-Guérin scars

TB might have affected it. In a study carried out in the pediatric age group was demonstrated that TST response increases with the increasing number of BCG scars; however, the diameter decreases in direct proportion to the time elapsed after BCG vaccination. In this study, there was a relationship between BCG scar counts and the induration diameter. However, there are also studies in which no relationship was detected.[9] It is known that the time elapsed after the vaccine affects the diameter of TST induration by decreasing it.[10]

In a study conducted in India that the results suggest that more than one-third of the HCWs had LTBI. Patients included in this study; the age of the participants ranging from 18 to 71 years, with a mean age of 27.13 years. TST induration size (mean 6.37 mm) the TST results showed that 36.8% (76/206) were infected with TB using a TST induration ≥10 mm as a cutoff point.[11] A stud by Lamberti *et al*. found that in the TST group, 73 (13.2%) individuals were found positive, none were found to have active TB in Italy, which is a low incidence country for LTBI.[12] In another study conducted in South Africa, which is high incidence country for LTBI, revealed that among 199 participants (150 [76%] females, median age 31 years [range 20–61]), incident LTBI was documented using IGRA in 25/97 (26%; incident rate 29 cases/100 person-years [py], 95% CI 20–44) and using TST in 25/93 (27%; incident rate 29 cases/100 py, 95% CI 19–42).[13] We determined that the mean diameter of induration was 12 ± 6 mm and none of those, who were the mean age of 39 ± 8, were diagnosed to have active TB. In a study, conducted in South Africa, a total of 120 HCWs, of HCWs 73.3% were nurses, of all participants 56.7% (68 patients) were TST positivity. However, 22 participants were HIV(+), and the agreement between TST and IGRA was fair (68.4%, κ = 0.37).[14] In addition, based on their occupations by considering their participant's exposure were not categorized. Another two studies, compared to agreement between TST and IGRA were similar results which were poor concordance between them.[13,15] In this study, participants were classified into five groups. We did not perform IGRA test, because, the WHO is recommended that comparative analysis between TST and IGRA in the head-to-head studies showed no evidence that one test should be preferred over the other to assess progression to TB disease.[16] In addition, according to the national guidelines reported that TST should be continued in our country. It is recommended that IGRA should be performed in people, who are strongly considered TB infections and immunosuppressed or immunosuppressive treatment candidates of TST-negative (with booster).[7] Another study, carried out in Greece, a total of 788 (physicians, nurses, allied health staff, patient services assistants, and clerical staff) were included. Most of the participants (83.9%) were aged between 30 and 49 years. The TST was performed in all 788 individuals; using a cutoff value of 10 mm, 286/788 (36.3%) were positive.[17]

Nienhaus *et al*. concluded that the prevalence of LTBI is the same for men and women. Similarly, there are no differences between doctors and nurses. LTBI prevalence is higher among geriatric care nurses; otherwise, no differences were described between the different occupational groups and activities in Germany.[18] When compared to this study, we revealed that there was a significant difference in terms of TST between genders ($P < 0.001$) and between doctors and nurses ($P = 0.039$). This discrepancy may be because of the detection frequency of LTBI among countries. In a study conducted regardless of direct patient contact in the USA performed a total of 2563 HCWs. Among 214 participants who reported prior BCG vaccination, 124 (57.9%) were negative on all three tests (TST, IGRAs, and T-SPOT). A baseline positive TST with negative IGRAs was associated with BCG vaccination. 15 (7.0%) were positive on all three tests, 58 (27.1%) had only a positive TST, and 17 (7.9%)

had other combinations of results.[19] Even though 124 were vaccinated with BCG, TST was negative them. There are some uncertainties at that point. Our patients all were vaccinated with BCG, and the rate of TST positivity was 38%, and none had active TB. Borroto *et al*. carried out that of the 350 HCWs, 82% were female; the mean age was 37.6 years. LTBI prevalence was 15.4%. Among the HCWs, physicians had the highest prevalence (21.8%), followed by nurses (19.6%), whereas administrative staff had the lowest prevalence (3.3%). The mean induration was 3.78 mm; it was the highest in professionals (4.4 mm) and the lowest among support staff (2.6 mm). Patients enrolled in this study 267 who were vaccinated with BCG. In addition of the total number of patients tested, 60.3% were nonreactors (0 mm). Nonreaction was more frequent among nonvaccinated than in vaccinated individuals (P = 0.02). However, overall, negative tests (0–9 mm) were not statistically significantly different in the vaccinated and nonvaccinated groups (P = 0.09). Of the total number of tests read, 15.4% (95% CI 11.2–20.9) were positive using 10 mm as the cutoff; 20/350 had reactions ≥15 mm. No statistically significant difference was found between the vaccinated and nonvaccinated groups in terms of positive cases (P = 0.09).[20] When compared to this study, it was concluded some different results. Since we showed that doctors were the lowest prevalence, security, cleaning, and cafeteria staff had the highest prevalence, nurses had between them. In addition, except nonreactive patients, there were no statistical differences between BCG vaccination and TST size in the remaining.

A study showed, in the HCWs, an incidence of LTBI at 4 years of 15.5%.[21] In countries with low incomes, annual mean incidence of LTBI is 5.8% in HCWs (range 0%–11%) whereas in those countries with the higher income it was 1.1% (0.2%–12%).[22] This variability can be due to a different level of exposure to patients with TB, which is estimated by the number of patients with TB admitted each year in each hospital, and by the existence or not of proper control measures in each institution. A recent review conducted by Baussano *et al*. estimated an LTBI rate of 3.8% (95% CI 3.0%–4.6%) for countries with a low TB incidence (<50 cases/100,000 population), and 6.9% (3.4%–10.3%) for countries with intermediate TB incidence (50–100 cases/100,000 population).[23] It was demonstrated that there was a statistically significant relationship between the number of BCG scars and the diameter of TST was significantly higher in HCWs with three BCG scars than HCWs with one scar.[24] Even though according to professions was separated, it was not evaluated the difference between occupations. In this study, it was detected similar results.

Conclusion

The results of TST differ according to their exposure in HCWs. Although incomes of them were not calculated, when the income situation is generally considered, the socioeconomic situation also seems important. We would like to detect baseline TST values in HCWs, to draw attention to TB and LTBI development in cases who had a conversion in their follow-ups, and to emphasize the importance of periodic follow-ups.

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Conflicts of interest

There are no conflicts of interest.

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