

Original article

Can job titles be predictors for recent onset latent tuberculosis in health care workers?

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Background: Tuberculosis is a common health problem in developing countries including Thailand. The association between occupation and recent onset of tuberculosis is unclear.

Objective: We studied the association of job types and tuberculin conversion or recent onset latent tuberculosis in healthcare workers in an endemic area of tuberculosis.

Design and Sample: A case-control study was done at Srinagarind Hospital, Thailand. Cases were subjects with tuberculin conversion, while controls were subjects with negative results of tuberculin skin test (TST) in two consecutive years.

Results: One thousand twenty five subjects completed two consecutive TST between 2001 and 2009. The rate of tuberculin conversion was 19.8% or 203 subjects. In a multivariate model, the only three significant factors for tuberculin conversion were male gender, having a BCG scar, and job type. Only nurses, nurse assistants, and ward workers were significantly associated with tuberculin conversion with adjusted odds ratio [95% confidence interval] of 2.3 [1.3-4.1], 2.3 [1.3-4.7], and 3.0 [1.8-5.0], respectively.

Conclusion: Being male, having a BCG scar, and certain job types increase the risk of latent tuberculosis in healthcare workers. Tuberculosis infection control program should emphasize job types for healthcare workers who are at increased risk.

Keywords: Healthcare workers, job title, latent tuberculosis

Latent tuberculosis (LTB) is the stage of *Mycobacterium tuberculosis* infection that is asymptomatic, dormant, and non-contagious [1]. A two-step tuberculin skin test (TST) is recommended for the prevention and control of tuberculosis [2]. A positive result of TST indicates LTB, while tuberculin conversion is evidence of recent onset LTB and indicates risk of active tuberculosis in the future [3, 4].

Although health care workers (HCW) are considered at high risk for LTB [5], it is of interest to know which job types are associated with the highest risk of LTB [6, 7]. We studied the association of job types and tuberculin conversion and recent onset of LTB in HCW by using a case-control study.

Materials and methods

Study population

This study was conducted at Srinagarind Hospital, Khon Kaen University, Thailand. The institutional review board and ethics committee of Khon Kaen University approved the study protocol. We recruited HCW who had results of TST within two consecutive years between April 2001 and March 2009. We chose this period because the new HCW in our hospital begin their positions in April. Subjects were excluded if one of these criteria were presented, history of recent or active tuberculosis, abnormal chest X ray, and history of diabetes mellitus, HIV infection, or having received any immunosuppressive therapy.

Cases were subjects with tuberculin conversion, while controls were subjects with negative results of TST in two consecutive years. Tuberculin conversion was defined if a subject had a negative baseline TST and a positive TST on the next consecutive years.

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TST was tested by injection of 0.1 ml of 5 tuberculin units of liquid tuberculin intradermally on forearm. A subject's forearm was examined independently by two infectious disease control nurses 48 to 72 hours after the injection. Reaction was defined as an area of induration around the site of the injection. The diameter of the indurated area was measured in millimeters. The average diameter between two readers was reported. An induration of 10 or more millimeters was considered a positive reaction. If the test was negative, the TST was repeated within the next three weeks to eliminate booster effect. This phenomenon occurs in people with previous BCG vaccination.

TST conversion was defined if a subject had a negative baseline TST and a positive TST in the next year. The induration of the second-year TST must be 10 millimeters greater than the first-year result that was initially less than 10 millimeters. The TST was repeated in 12 months for those with a negative first-year TST. An annual TST surveillance of health care workers is not standard practice in Srinagarind Hospital or in most health care facilities in Thailand.

Data collection

We recorded subject's data from infection control unit charts including the baseline characteristics, job types, duration of employment (years), presence of bacillus Calmette-Guerin (BCG) scar, history of tuberculosis in family members or colleagues, history of tuberculosis exposure at workplace in the past year, history of previous TST, and history of using surgical, N95 or HEPA mask. The frequency of mask use was defined by using it at all times or occasionally while working.

Job types were defined by title and job responsibilities. Office staff deal with patients' administration processes such as registration, admission, or discharge. Physicians and nurses are defined by titles. Nurse assistants' duties are to record patients' vital signs and intake/output, and to assist in patients' hygiene. Ward workers take responsibilities in preparing medical devices, cleaning medical devices, and maintenance of hospital sanitation.

Data analysis

Baseline and clinical characteristics of cases and controls were compared using descriptive statistics. Wilcoxon rank-sum or student *t*-test and Fisher's exact tests or Chi-square test was applied to compare the

differences in numbers and proportions between the two groups, respectively.

Univariate logistic regression analyses were applied to calculate the crude odds ratios of individual variables for the development of tuberculin conversion. All variables with *p* values <0.25 in univariate analysis were included in subsequent multivariate logistic regression analyses. All variables with *p*<0.10 were retained in the final model by backward elimination technique. Analytical results were presented as crude odds ratios (OR), adjusted OR, and 95% confidence intervals (CI).

The goodness-of-fit of the final model was evaluated using Hosmer-Lemeshow statistics [8]. To evaluate the discriminatory power or accuracy of the model, *c* statistics or area under the receiver operating characteristic curve were examined [9]. All data analyses were performed with SAS software version 8.2.

Results

In 2001, there were 3,075 health care workers in our hospital. Of those, 1,025 subjects (33.3%) completed two consecutive TSTs. Two hundred three subjects (19.8%) had tuberculin conversion (case group). The baseline characteristics and variables related to tuberculosis of the case and control groups were presented in **Table 1**. The case group had older age, more male subjects, longer duration of employment, and more subjects with BCG scar, history of tuberculosis in family members, history of tuberculosis exposure in the past year, and history using prevention by any methods and by surgical mask. There were higher numbers of nurses, nurse assistants, workers, and technicians in the tuberculin seroconversion group.

In a multivariate model that included all variables significant at the univariate level (**Table 2**), the only three significant factors for tuberculin conversion were male gender, having a BCG scar, and certain job types (**Table 2**). The adjusted odds ratio (95% confidence interval) of male gender and having BCG scar were 3.0 (1.9-4.6) and 1.5 (1.0-2.3), respectively. Of job types, only nurses, nurse assistants, and ward workers were significantly associated with tuberculin conversion with adjusted odds ratio [95% confidence interval] of 2.3 (1.3-4.1), 2.3 (1.3-4.7), and 3.0 (1.8-5.0), respectively. For the final model, the Hosmer-Lemeshow value and the *c* value were 5.35 (*p* value 0.71) and 66.5, respectively.

Table 1. Baseline characteristics of subjects with and without TST conversion.

Variables	No conversion (n = 822)	Conversion (n = 203)	p value
Median age (range), years	27 (17-59)	38 (17-58)	<0.0001
Male gender	225 (27.4)	73 (36.0)	0.0158
Median duration of employment, years	11 (2-31)	17 (2-27)	0.0510
Jobs			<0.0001
Office staff	480 (58.3)	65 (32.0)	
Physicians	90 (11.0)	17 (8.4)	
Nurses	80 (9.7)	35 (17.2)	
Nurse assistants	68 (8.3)	30 (14.8)	
Ward workers	73 (8.9)	44 (21.7)	
Technicians	31 (3.8)	12 (5.9)	
Tuberculosis related variables			
BCG scar	469 (57.1)	135 (66.5)	0.0150
History of tuberculosis in family	38 (4.6)	17 (8.4)	0.0332
Years of tuberculosis in family, years	8 (1-36)	5.5 (1-23)	0.3648
History of tuberculosis in colleagues	41 (5.0)	12 (5.9)	0.5839
History tuberculosis exposure in the past year	150 (18.3)	61 (30.2)	0.0002
Prevention related variables			
History of prevention by any methods	291 (35.4)	113 (55.7)	<0.0001
History of surgical mask use	274 (33.6)	103 (51.0)	0.0053
History of N95 use	16 (44.4)	7 (25.0)	0.1240
History of hepa use	1 (7.1)	3 (30.0)	0.2721
Frequency of surgical mask use at all time	105 (40.0)	46 (47.4)	0.2296

Data present in number (%), unless indicated. Data for no conversion and conversion group may not total 822 and 203, respectively, because of missing data.

Table 2. Results of univariate and multivariate regression analyses showed independent variables and their crude odds ratios (ORs) and adjusted odds ratios (Adjusted ORs) with 95% confidence interval (95% CI) for being TST conversion.

Variables	ORs (95%CI)	Adjusted ORs (95%CI)
Male gender	1.5 (1.1-2.1)	3.0 (1.9-4.6)
BCG scar	1.5 (1.1-2.1)	1.5 (1.0-2.3)*
Jobs		
Office staff	1.0	1.0
Physicians	1.4 (0.8-2.5)	0.9 (0.2-4.4)
Nurses	3.2 (2.0-5.2)	2.3 (1.3-4.1)
Nurse assistants	3.2 (2.0-5.4)	2.3 (1.3-4.7)
Ward workers	4.5 (2.8-7.0)	3.0 (1.8-5.0)
Technicians	2.9 (1.4-5.8)	1.2 (0.5-2.6)

*p value <0.05

Discussion

Our results emphasize the association of job types and the occurrence of tuberculin conversion in HCW. In addition, male gender and having a BCG scar are significant risk factors for LTB in our hospital.

The LTB prevalence in HCW varied from country to country. It can be as low as 7.2% or as high as 79% with an average of 54% [10], while our TST conversion rate ranged from 3.9% to 14.3%. Our tuberculin conversion or recent LTB rate was slightly higher than average [11] because we are located in high burden country as categorized by World Health Organization (WHO).

Data regarding risk factors of tuberculin conversion in HCW are still limited. Even though risk of LTB in HCW has been shown, the association of job titles or descriptions and recent LTB are sparse. Physicians may be generally considered as a high-risk group for LTB [7], but our analysis showed that physicians are not significantly at risk for recent LTB. Only nurses, nurse assistants, or ward workers are the three significant jobs that related to recent LTB. The risks of tuberculin conversion of those three jobs are about two to three times annually. Technicians are significantly related to tuberculin conversion by univariate analysis. However, after adjusting for other factors, it is no longer significant in a multivariate analysis.

Immunization with BCG has been known to be related to LTB or positive TST in HCW [6, 12-14]. History of BCG immunization was shown to be associated with LTB by an epidemiological study [6]. Similarly to previous report from Brazil [12], we confirmed that a BCG scar is also associated with tuberculin conversion or recent onset LTB in HCW. We have no explanation or theory for this finding. Experimental studies showed that when a person inhales tuberculosis bacteria, prior to BCG vaccine, this does not prevent the initial infection [15, 16]. In other words, BCG is not thought to prevent *M. tuberculosis* infection [17, 18]. Our findings raise the possibility of association of previous BCG immunization and recent onset LTB in HCW. A recent study showed that BCG vaccination might not be effective [19]. However, it may be beneficial to prevent tuberculous meningitis in children [20].

Some studies showed that men had a higher risk of TST positivity or LTB [21, 22]. Our results added male gender as a risk factor of recent onset LTB. These findings might be explained by a higher rate

of community exposure among males or cultural-economic factor [7]. The tuberculosis control program may need to pay more attention to male HCWs regarding higher risk for recent onset LTB.

In summary, certain job types do increase risks of recent onset of latent tuberculosis in health care workers, particularly nurses, nurse assistants, ward workers, male HCW, and those with BCG scar. Tuberculosis infection control program should focus on those who are at risk.

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