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Pulmonary tuberculosis infection among workers in the informal public transport sector in Lima, Peru

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ABSTRACT

Background Because a strong association was observed between pulmonary tuberculosis (TB) and the use of public transport, increasing with duration of journey, a study was carried out to assess infection by *Mycobacterium tuberculosis* and working conditions among workers in this sector.

Methods A cross-sectional study was conducted between June and September 2008. A total of 104 workers from two public transport minibus (‘combi’) cooperatives covering marginal areas of the Ate-Vitarte district in Lima were interviewed. Demographic and occupational details were collected as well as prior family and personal history of TB and BCG vaccination. The tuberculin skin test (TST) was administered to each study subject and an induration of ≥10 mm was considered positive. Statistical analysis was based on logistic models, ORs and their 95% CIs.

Results TST results were obtained for 70.2% (n=73), of whom 76.6% (n=56) were positive. Positivity was significantly associated with those who had worked for more than 2 years (crude OR 11.04; 95% CI 3.17 to 38.43) and more than 60 h/week (crude OR 9.8; 95% CI 2.85 to 33.72). These associations remained significant in a multivariate model as well.

Conclusion The association observed between years of working and weekly work burden among minibus workers suggests an occupational risk in service jobs in low-income countries with high TB prevalence. Consequently, other types of users are at increased risk for TB infection, with a causal relationship between effect and duration of exposure.

INTRODUCTION

Smear-positive pulmonary tuberculosis (PTB) is a major public health problem due to its transmission within the community. A person with untreated smear-positive PTB can infect 10–15 people each year.1 Even when the transmission pattern is known, in most South American countries only household contacts are screened with no screenings in work locations. Public transportation is a documented setting where people are exposed to TB infection and other airborne pathogens, particularly in countries with a high prevalence of PTB.2–4 The urban public transportation services in Peru, as in other South American countries, have inadequate environmental conditions and a high risk of airborne pathogens. Vehicles are frequently overcrowded, regulations on the length of the working day are ignored and break times are not taken. Thus, overcrowding and increased worker exposure times represent an occupational risk.

What this paper adds

- An association between pulmonary tuberculosis and the use of public transport (minibus) has previously been shown.
- Moreover, the strength of this association increases as trip duration increases.
- We have observed an association between positive tuberculin skin test results and the poor working conditions of minibus workers in a precarious occupational setting, characteristic of low-income countries with high tuberculosis prevalence.
- Minibus workers in such countries should therefore be included in occupational health programs.

The objective of this study was to evaluate the risk of *Mycobacterium tuberculosis* infection in public transportation workers in the Ate-Vitarte district in Lima, a marginal area with high PTB prevalence.

MATERIAL AND METHODS

Based on a previous study design in the transportation setting,2 two minibus cooperatives were selected from 14 operating services to the study area. A total of 106 workers, 50 drivers and 56 fare-collectors over 15 years of age, volunteered and were included. They were fully informed of the objectives of the study and of the opportunity to enrol in a TB program when appropriate. Two workers undergoing active TB treatment were excluded from the study and there were no refusals.

The remaining 104 study participants were interviewed at central bus stations. Demographic and occupational data were collected, including age, sex, years of employment in the transportation sector, hours worked per day, number of days worked per week, and personal and family history of TB.

At the time of the interview, each subject was administered the tuberculin skin test (TST) in accordance with the Peru Tuberculosis Program, following the standard Mantoux technique1 consisting of an intradermal injection of purified protein derivative (PPD-RT 23 SSI 2UT (0.1 ml); Statens Serum Institut, Copenhagen, Denmark; obtained from the Peruvian National Institute of Health).1 Indurations were measured 48–72 h after administration and those ≥10 mm were considered positive.5–8 Duration of employment was grouped
into 0–2 years and more than 2 years.\(^5\) Regarding exposure time, the number of hours worked per week was calculated based on scheduled services and information from the Ministry of Transportation on vehicles, drivers and fare-collectors, and then categorized into more or less than 60 h per week.\(^9\) It was estimated that workers worked an average of 12 h per day, 5 days per week, exceeding the working hours officially established in Peru for all occupations (8 hours per day or 40 hours per week).

The study was approved by the Ethics Committee of Health Directorate IV (East Lima), Ministry of Health.

### Statistical analysis
A sample size was calculated to obtain 10% precision of the estimated proportion of 60% of positive TSTs.\(^10\) (\(n=92\) \((\alpha=0.05)\). Subjects were chosen from only two companies so that all workers in both companies could be studied (\(n=104\)). Subsequently, we included participants who returned within the stipulated time for the TST reading. A sub-study of non-responders was conducted using two-sided \(t\) tests for mean contrasts and exact tests of proportions to detect possible biases.

Univariate and bivariate analyses, as well as a multivariate logistic model, were preformed. ORs and 95% CIs were calculated. Data were analysed using SPSS v 15.

### RESULTS
A total of 104 workers were interviewed and administered a TST, and of these 73 (70.2%) returned for the TST reading, of whom 56 (76.6%; 95% CI 66.9% to 86.3%) were TST positive.

The mean (SD) age of the 73 who returned for the test reading was 35.9 (9.1) years. None had a known history of TB, although three (4.1%) were uncertain. Nine (12.3%) stated they had been infected with TB. Arm scars compatible with prior BCG vaccination were found in 68 (93.2%) subjects.

The 31 who did not return for the test reading were not significantly different from responders with regard to age (mean 30.1 years), BCG (87%), family history (9.7%), years in the job (64.5%) or hours worked per week (48.4%).

Fifty-one subjects (69.9%) had worked in public transportation for more than 2 years and 50 (68.5%) worked more than 60 h per week.

According to the bivariate analysis, no association was found between a positive TST and a family history of TB (Fisher exact test, \(p=0.105\)). A positive TST was found to be associated with more than 2 years of employment (OR 11.04; 95% CI 3.17 to 38.43) and with working more than 60 h per week (OR 9.8; 95% CI 2.85 to 33.72). When controlling for age using a logistic multivariate model, the following were associated with a positive TST result: more than 2 years of employment (adjusted OR 11.04; 95% CI 3.17 to 38.43). When controlling for age using a logistic multivariate model, the following were associated with a positive TST result: more than 2 years of employment (adjusted OR 11.04; 95% CI 3.17 to 38.43). When controlling for age using a logistic multivariate model, the following were associated with a positive TST result: more than 2 years of employment (adjusted OR 11.04; 95% CI 3.17 to 38.43). When controlling for age using a logistic multivariate model, the following were associated with a positive TST result: more than 2 years of employment (adjusted OR 11.04; 95% CI 3.17 to 38.43). When controlling for age using a logistic multivariate model, the following were associated with a positive TST result: more than 2 years of employment (adjusted OR 11.04; 95% CI 3.17 to 38.43). When controlling for age using a logistic multivariate model, the following were associated with a positive TST result: more than 2 years of employment (adjusted OR 11.04; 95% CI 3.17 to 38.43). When controlling for age using a logistic multivariate model, the following were associated with a positive TST result: more than 2 years of employment (adjusted OR 11.04; 95% CI 3.17 to 38.43). When controlling for age using a logistic multivariate model, the following were associated with a positive TST result: more than 2 years of employment (adjusted OR 11.04; 95% CI 3.17 to 38.43). When controlling for age using a logistic multivariate model, the following were associated with a positive TST result: more than 2 years of employment (adjusted OR 11.04; 95% CI 3.17 to 38.43).

### DISCUSSION
The validity of the TST is controversial because of its low sensitivity and specificity, lack of reactivity due to immunological depression, and cross-reactions with other mycobacterial species.\(^11\) There are also some limitations to using it in adult populations in countries with high TB prevalence, such as Peru. However, it is still the most common technique for diagnosing TB infection,\(^5\) even among BCG-vaccinated populations,\(^12\) because of its easy application and interpretation, and low cost.\(^13\)

The use of public transport was found to be a risk factor for PTB infection in a previous study conducted in the same geographical area,\(^2\) in which journey duration was used to assess exposure. This theoretical framework led to our hypothesis that similar findings would be observed among subjects considered exposed to TB infection because they worked as minibus (combi) drivers and fare-collectors.

Among the study population, 93.2% had arm scars compatible with prior BCG vaccination. Given the characteristics of the Peruvian TB Prevention Program and the mean age of the subjects, we calculated that they were vaccinated more than 15 years ago (including those re-vaccinated after 6 years) and thus it is unlikely prior vaccination influenced TST results.\(^13\) Moreover, the association between occupational characteristics and \(M.\) \textit{tuberculosis} infection, adjusted for age, provides a specific epidemiological profile given these working conditions: an informal work setting, lack of a job contract, lack of fixed break times, no health insurance and no health benefits.

In this context, the response rate obtained was optimal and perhaps linked to health concerns among these workers (data not shown). The high rate of TST positivity of 76.6% (95% CI 66.9% to 86.3%) was higher than the results observed in contact tracing studies (55–61%)\(^10\) and suggests high exposure in this setting.

Furthermore, the prolonged daily and weekly exposure suggests that the association is not coincidental and that a worker with active PTB is a transmission source for passengers. Despite AFB+ TB presentation, some workers continue working, as shown by the two employees excluded from the study, or may default from anti-TB treatment when signs and symptoms have minimised\(^14\) or because of incompatibility between their working hours and those of health centres. Therefore, minibus workers and companies should be targeted for specific and effective preventive interventions within occupational health programs.

The characteristics revealed in our study show that there is a risk of infection among urban transportation workers in cities with high TB prevalence. Furthermore, one must consider the repercussions for passengers. This association must be interpreted in the context of working and environmental conditions.

### Table 1 Predictive factors for tuberculin skin test positivity in workers in the informal public transport sector, Lima, Peru

<table>
<thead>
<tr>
<th>Variable</th>
<th>TST+ n/N (%)</th>
<th>Crude OR</th>
<th>95% CI</th>
<th>Adjusted OR by age</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time in job</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\leq 2) years</td>
<td>10/22 (45.5)</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;2 years</td>
<td>46/51 (80.2)</td>
<td>11.04</td>
<td>3.17 to 38.43</td>
<td>15.66</td>
<td>3.25 to 75.35</td>
</tr>
<tr>
<td>Hours/week</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\leq 60) h</td>
<td>11/23 (47.8)</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;60 h</td>
<td>45/50 (90.0)</td>
<td>9.8</td>
<td>2.85 to 33.72</td>
<td>12.7</td>
<td>2.72 to 49.45</td>
</tr>
<tr>
<td>Age</td>
<td>1.02</td>
<td>0.96 to 1.08</td>
<td>1.06</td>
<td>0.98 to 1.15</td>
<td></td>
</tr>
</tbody>
</table>

Reference categories: \(\leq 2\) years in job and \(\leq 60\) h/week.

TST, tuberculin skin test.
The transmission of TB in large cities in TB endemic countries with increased circulation of resistant mycobacteria, such as Lima, Peru, makes the risk of infection even greater. Because all anti-TB treatment is administered through outpatient facilities, transmission in this setting can also include drug-resistant and extremely drug-resistant TB strains.14

In conclusion, a home-based directly observed treatment strategy should be considered for confirmed TB patients to avoid exposure within the workplace, such as the public transportation sector.

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Competing interests None.

Ethics approval This study was conducted with the approval of the Ethics Committee of Health Directorate IV (East Lima), Ministry of Health.

Provenance and peer review Not commissioned; externally peer reviewed.

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