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The association between public transportation and active tuberculosis in Lima, Peru

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Case control study in Lima, Peru correlates public transportation use with developing active TB.

Tuberculosis and Public Transportation in Lima

To the Editor,

While there have been impressive gains in the global control of Tuberculosis (TB) over the past two decades, TB remains a leading cause of death and efforts to decrease its burden have been limited by the rise of drug resistant strains [1]. Since drug resistant tuberculosis remains exceedingly difficult and costly to treat, more research is needed to identify areas for improving primary prevention of TB.

The risk of TB transmission is increased whenever there is overcrowding, poor ventilation, and exposure to an infected individual, and public transportation has been identified as a potential setting with increased risk for TB transmission [2]. Indeed, recent research demonstrates the fraction of rebreathed air in public transportation is mathematically correlated with a higher risk of contracting TB [3].

Previous investigations using cross-sectional data in Lima, Peru have demonstrated that community, rather than household transmission, may account for up to 70% of incident infections [4]. Studies conducted in Lima found an increased risk of TB infection among individuals who rode mini-buses [5] and those who worked in public transportation [6]. However these studies were limited by misclassification of TB diagnosis, imprecise time variables, and wide confidence intervals.

The objective of our study was to assess the association between use of public transportation and active TB using a detailed transportation questionnaire, multiple control groups, and improved TB diagnostics.

We utilized a matched case-control design and enrolled treatment-naïve individuals newly diagnosed with tuberculosis on the day of diagnosis from three peripheral health centers in the Lima metropolitan area. Three controls without tuberculosis were individually matched by age and gender for each incident case: a patient with a symptomatic respiratory syndrome from the same clinic as the incident case, a person living in the same household as the case, and a person from the same neighborhood as the case using random number sampling. Controls were excluded if they had a prior history of TB, were HIV positive or pregnant, or if they were currently living with anyone with active TB (with the exception the incident case for household control). Cases and symptomatic controls underwent confirmatory testing with solid and liquid cultures to decrease misclassification.

Each participant completed a survey assessing demographic and socioeconomic factors, risk factors for TB, and transportation habits. Since transportation use was likely to vary throughout the year, subjects were also asked about transportation use during the prior. To reduce confounding by indication, cases and symptomatic respiratory controls were asked about transportation use the week before onset of respiratory symptoms. The association between use of public transportation and active TB was modeled with logistic regression. Each covariate was evaluated and included in the model if it had an independent association between cases and controls ($p \leq 0.05$) and all covariates were tested for multicollinearity. Time spent in transportation was converted to quintiles due to skewing of the mean by public transportation workers, who reported spending >920 minutes each week in public transportation.

We enrolled 86 cases and 86 household, 86 neighborhood, and 85 symptomatic respiratory syndrome controls. Control groups did not vary significantly from each other and were therefore pooled in the analysis. Compared to controls, cases had lower body mass index (BMI), had a history of exposure to a household member with TB, differing occupations, and more frequent travel between 15:00-18:59. Other TB risk factors including income, number of household inhabitants, years of education, BCG history, alcohol or tobacco use, diabetes, and perception of TB exposure outside of the home did not significantly vary between case and control. There was also no significant difference between transportation types. The significant covariates were included in a multivariate logistic regression model to assess transportation in the past week or past year with the risk of developing TB (Table).

In the model assessing transportation use during the prior week, an increase in one quintile of time spent in public transportation increased the odds of having tuberculosis by 34% (OR=1.34; 95% CI: 1.08, 1.65; p=0.007). There was also an association between transportation use over the past year and risk of tuberculosis, but it was not significant (OR=1.19; 95% CI: 0.97, 1.46; p=0.093). Lower BMI, previous cohabitation with a person with TB, and being divorced or widowed was associated with a higher risk of tuberculosis, while working as a professional in jobs requiring certification such as healthcare, business, and education was associated with a lower risk of tuberculosis. There was an association between increased risk of tuberculosis with travel during 15:00-18:59 which was statistically significant for the yearlong model, but not for the past week model. There was no significant effect modification among any of the covariates tested with duration of time in public transportation.

Our study design decreased misclassification of active TB by using highly sensitive and specific TB culture techniques, recruiting a larger sample size, and using a detailed survey of public transportation parameters. These attributes and the control of the known TB risk factors of prior cohabitation with a person infected with TB and BMI [8] lend further support to the likelihood that public transportation is an independent risk factor for TB transmission. While risk of TB from prior household contact exceeded the risk associated with transportation use, our study did not assess other potential venues of community TB transmission such as workplace environments, sporting events, and marketplaces.

Although our analysis did not detect a significant association between travel duration and TB over the yearlong period, this information was self-reported and therefore resulted in a simplified estimation of transportation use over the past year, leading to non-differential misclassification of the exposure towards the null. This is a documented challenge among questionnaires that require recall over a yearlong period [7]. A more accurate estimation of transportation use would require use of prospective travel logs, but this was not feasible for the scope of this study.

In the yearlong mode, there was an increased risk of TB among those traveling between the hours of 15:00 to 18:59. This time frame encompasses the typical evening rush hour period in Lima where there is increased transportation use and overcrowding. This finding suggests that certain routes and time frames may be linked with increased TB risk and serve as a medium for transmitting TB to other neighborhoods. This hypothesis is supported by the finding in another study that specific bus routes traverse areas clustered with TB [9].

With respect to the post-2015 WHO goal of TB elimination by 2050 defined as <1 case per million population, identifying and prioritizing treatment of individuals with latent TB (LTB) at high risk of progression is essential to prevention [10]. Given the demonstrated risk conveyed by prior household TB exposure, our study affirms the importance of household contact tracing for TB and LTB case finding and treatment. It also identifies public transportation as a source of community transmission. Further study of the interactions of transportation time, type, routes, and degree of congestion with the risk of TB is merited to identify targeted preventative interventions and ascertain the role of these interventions in existing prevention programs.

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Table: Adjusted association between time spent in public transportation and active pulmonary tuberculosis in Lima, Peru.

	Transportation Use in the Week Prior to Enrollment (n=343)			Transportation Use per Week in the Last Year (n=343)		
Characteristic	OR	95% CI	P value	OR	95% CI	P value
BMI	0.78	(0.69, 0.88)	<0.001	0.78	(0.70, 0.87)	<0.001
Past Household TB Exposure*	3.28	(1.83, 5.89)	<0.001	3.38	(1.90, 6.04)	<0.001
Marital Status						
Single	1.00	Reference		1.00	Reference	
Married	0.66	(0.14, 3.17)	0.603	0.62	(0.14, 2.83)	0.545
Cohabitation	0.70	(0.33, 1.47)	0.346	0.64	(0.30, 1.36)	0.242
Divorced/Widowed	5.25	(1.39, 19.7)	0.015	5.13	(1.36, 19.4)	0.016
Occupation						
Student	1.00	Reference		1.00	Reference	
Professional	0.16	(0.03, 0.79)	0.025	0.18	(0.04, 0.88)	0.034
Laborer	1.13	(0.53, 2.38)	0.753	1.13	(0.53, 2.40)	0.757
Commercial	1.30	(0.50, 3.38)	0.584	1.29	(0.49, 3.42)	0.608
Domestic	0.92	(0.28, 3.00)	0.886	0.93	(0.29, 2.98)	0.906
Public Transportation	0.20	(0.04, 1.07)	0.059	0.27	(0.47, 1.59)	0.148
Unemployed	1.61	(0.42, 6.15)	0.483	1.81	(0.50, 6.55)	0.364
Travel between 15:00-18:59	1.77	(0.99, 3.14)	0.053	1.85	(1.03, 3.31)	0.038
Time in Transportation †,‡						
Quintile 1	1.00	Reference		1.00	Reference	
Quintile 2	1.09	(0.43, 2.74)	0.861	1.86	(0.78, 4.47)	0.163
Quintile 3	2.00	(0.85, 4.73)	0.115	1.52	(0.66, 3.46)	0.324
Quintile 4	2.81	(1.12, 7.07)	0.028	2.56	(1.06, 6.20)	0.037
Quintile 5	2.60	(0.99, 6.78)	0.050	1.82	(0.70, 4.93)	0.241
Each Quintile	1.34	(1.08, 1.65)	0.007^	1.19	(0.97, 1.46)	0.093^

* Past TB exposure from living with someone who had tuberculosis previously

† Time in transportation last week: Quintile 1= <120 minutes, Quintile 2= 120-279 minutes, Quintile 3= 280-539 minutes, Quintile 4= 540-919 minutes, Quintile 5= ≥920 minutes.

‡ Time in transportation per week last year: Quintile 1= <180 minutes, Quintile 2= 180-319 minutes, Quintile 3= 320-599 minutes, Quintile 4= 600-899 minutes, Quintile 5= ≥900 minutes.

^ P value for trend