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Area-based socio-economic disadvantage and tuberculosis incidence

E. Oren,*† T. Koepsell,* B. G. Leroux,‡ J. Mayer*

***Department of Epidemiology, University of Washington, Seattle, Washington, †Public Health—Seattle & King County, Seattle, Washington, ‡University of Washington Department of Biostatistics, Seattle, Washington, USA**

SUMMARY

OBJECTIVE: To examine neighborhood-level influences on tuberculosis (TB) incidence in a multilevel population-based sample.

DESIGN: All incident TB cases in Washington State, United States (n = 2161), reported between 1 January 2000 and 31 December 2008 were identified. Multivariate Poisson analysis was used at the ZIP Code™ tabulation area (ZCTA) level, which allowed for further exploration of area-specific influences on TB incidence.

RESULTS: A significant association was found between indices of socio-economic position (SEP) and TB incidence in Washington State, with a clear gradient of higher rates observed among lower ZCTA socio-economic quartiles. Compared to the wealthiest SEP quartile, the relative incidence of TB in successively lower quartiles was respectively 2.7, 4.1 and 10.4 (P trend <0.001). In multivariate analyses, the addition of area-level race, ethnicity and country of birth significantly attenuated this association (adjusted incidence rate ratios 2.3, 2.6, 5.7; P trend <0.001).

CONCLUSION: This study found a significant inverse association between area measures of socio-economic status (SES) and TB incidence across ZCTAs in Washington State, even after adjusting for individual age and sex and area-based race, ethnicity and foreign birth. These results emphasize the importance of neighborhood context and the need to target prevention efforts to low-SES neighborhoods.

KEY WORDS: TB; socio-economic factors; neighborhood; multilevel analysis

TUBERCULOSIS (TB) represents one of the world's greatest causes of morbidity and mortality, with a disproportionate burden falling on the poor.[1,2] That being poor is a risk factor for TB has been recognized qualitatively since the early nineteenth century.[3] Ecologic studies in the United States and the United Kingdom have shown associations between TB incidence and individuals or areas with lower levels of education, greater income inequality and poverty.[2,4–6] In keeping with this pattern, Washington State, USA, has historically high rates of disease among poor immigrants, as well as one of the largest homeless outbreaks in North America.[7]

While individuals living in socio-economically disadvantaged neighborhoods are at greater risk for poorer health outcomes in general than those living in better material circumstances,[8,9] the aforementioned studies did not use a multilevel approach allowing for the simultaneous examination of the effects of individual and area-level factors on risk of TB disease.[10]

We conducted a multilevel analysis of individual-level risk factors as well as ZIP Code™ tabulation area (ZCTA) level demographic and socio-economic factors and TB incidence in Washington State. The study was designed to address confounding by the sex and age composition of different ZCTAs. The primary hypothesis was that small-area-based socio-economic disadvantage would be associated with higher TB incidence, after controlling for individual age and sex and other area-level covariates. In addition, we examined whether TB incidence rates in one ZCTA were similar to rates in neighboring areas due perhaps to similar socio-economic status (SES).

STUDY POPULATION AND METHODS

All incident TB cases in Washington State (n = 2161) reported to local TB control programs between 1 January 2000 and 31 December 2008 were included in the analysis. Incident cases were defined as newly reported cases within the local health jurisdiction. A total of 569 ZCTAs were included in the study (mean population n = 10 359). ZCTAs were excluded if population (n = 15) or SES data (n = 4) were unavailable for that ZCTA. ZCTAs represented aggregations of census blocks whose mailing addresses shared the same predominant ZIP Code in 2000.[11]

Correspondence to: Eyal Oren, Tuberculosis Control Program, HMC-PH-0100, 325 Ninth Avenue, Seattle, WA 98104, USA. Tel: (+1) 206 744 2196. Fax: (+1) 206 744 4350. e-mail: eoren@uw.edu
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The analysis combined surveillance data for TB cases with US census data for residents of Washington State.

Human subject approval was granted for this study in May 2009 from the University of Washington and Washington State Institutional Review Boards.

Data sources

Individual-level data on all TB cases, including age, sex, race and ZIP Code of residence, were obtained from the Washington Department of Health. Case data are routinely reported through the National TB Surveillance System. Using a geographic information system and ZIP Code latitude/longitude coordinate data, TB cases were geocoded to the centroid of the corresponding ZCTAs. A small proportion of cases (5.6%) were excluded as they could not be geocoded at the ZCTA level.

All socio-economic and area-based data, including demographic composition, were derived from US Population Census 2000, Summary File (SF) 1 and SF3 files.[12] A standardized *Z*-score was created for percentage under poverty, working class percentage, median household income, percentage with expensive homes (house value >US$300 000), percentage that had completed high school and percentage of unemployment. After reversing some component *Z*-scores to account for polarity, scores were averaged to construct a summary deprivation measure or socio-economic position (SEP) index, consistent with a previously validated composite measure from the Public Health Disparities Geocoding Project.[13] The Project developed this measure based on a factor analysis of 11 SES factors, using rank values of the census data. Information on the prevalence of risk factors such as human immunodeficiency virus (HIV) infection, diabetes, substance abuse and poor nutrition was unavailable at the ZCTA level.

SEP index was modeled as a four-level categorical variable, using quartiles in the ZCTA distribution as cut-offs, with the highest quartiles representing the 'wealthiest' ZCTAs. In addition, other socio-economic variables (percentage owning homes, percentage of crowding) were modeled singly. The proportion of ZCTA observations for which SES data were missing was small (0.7%).

Statistical analysis

All area-based measures derived from the US census data were merged with the case ZCTA data file based on the ZCTA identifier and non-missing SES (n = 2448 records). To evaluate TB incidence, TB incidence rates were calculated for each ZCTA by dividing the total number of TB cases in a particular age and sex stratum of that ZCTA by the corresponding stratum population, multiplied by the 9 years in the reporting period (i.e., the denominator was person-years, estimated by multiplying the average estimated population by study period duration).

To describe the shape of the association between SES measures (both as single measures and as the SEP index) and TB incidence, relative risks compared those TB cases located in each SES ZCTA quartile with the highest SES ZCTA quartile, which served as a referent category. Cuzick's non-parametric test for trend across ordered groups was assessed across each SES measure as a summary test of statistical significance.[14] All ZCTA-level covariates were categorized into quartiles based on percentile distributions in 2000 ZCTA populations, with the lowest quartile serving as referent group. Incidence rate ratios (IRRs) compared those TB cases located in each covariate ZCTA quartile with the quartile directly below.

Multilevel multivariate Poisson regression was applied to assess the association between socio-economic factors and TB incidence. The form of the model was as follows:

$$\log(c_{ijk}) = \log(n_{ij}) + \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \beta_3 x_{3i} \ldots + \beta_k x_{10i} + \mu_i$$

where c_{ijk} was the expected number of cases of TB in a particular age × sex subgroup within a ZCTA summed over the years 2000–2008, n_{ij} represented total person-years based on the age and sex distribution of the ZCTA, β_0 was the intercept, x_{1ij}–x_{2ij} identified the cell as to age and sex, x_{3i}–x_{6i} identified the four ZCTA-level SEP index exposure measurements and x_{7i}–x_{10i} identified the other area-level covariates. μ_i represented the ZCTA-specific random effect. Subscript i indexed the individual's age group, j the sex and k the ZCTA. Individual-level characteristics (other than age and sex) were unavailable for non-cases in each ZCTA and were not included in multilevel analyses.

Nesting of individuals within ZCTAs violates independence assumptions unless accounted for, and underestimates standard errors.[15] Patient and census data were stratified simultaneously by ZCTA, age and sex. Cases and person-time at risk were also aggregated within each age-sex stratum across ZCTAs within each SEP index quartile.

Models run were as follows: Model 1 consisted of the unadjusted SEP index and Model 2 the individual covariates of age and sex as well as ZCTA-level SEP index. Model 3 added ZCTA-level covariates of ethnicity, race and foreign birth in addition to the individual-level variables and ZCTA-level SEP index. Models were fitted using STATA version 10 (Stata Corp, College Station, TX, USA).

Global Moran's *I*-statistics compared observed associations between case counts in a given ZCTA and its neighboring ZCTAs to those of a spatially random reference distribution to assess whether case rates were clustered in space. The strength of correlation between observations was estimated as a function of the distance separating each ZCTA. GeoDa version 0.9.5-I (Arizona State University, Tempe, AZ, USA) was used to implement exploratory spatial data analyses.

RESULTS

Descriptive analysis

A total of 2161 cases of TB were reported to the US Centers for Disease Control and Prevention from Washington State between January 2000 and December 2008, 1983 (91.8%) of whom were defined as incident. TB cases are described in Appendix Table A1.* Incidence rates were highest among Asians (30.1/100 000), Blacks (22.7/100 000) and Native Hawaiians (21.3/100 000). Hispanics exhibited incidence rates that were more than twice as high as among non-Hispanics. Incidence rates among the foreign-born population (27.7/100 000) were more than 20 times higher than in the US-born (1.3/100 000). Incidence rates increased rapidly with age, and were also high among the homeless (131.9/100 000) and unemployed (55.8/100 000). HIV co-infection was documented in approximately 6% of cases for whom HIV status was known.

Characteristics of the ZCTAs included in the analysis are shown in Appendix Table A2 (some ZCTAs were very rural and homogeneous, or contained few individuals). The mean neighborhood proportion living below the poverty level was 13.2%. The mean incidence of TB in the 569 ZCTAs included in the analysis was 4.0/100 000 person-years, with significant variation in incidence rates observed across ZCTAs, from 0 to 258/100 000. TB cases were observed in 282 distinct ZCTAs (48.0%).

Geographic variation

We evaluated ZCTA of residence to determine whether there were areas in Washington State associated with increased TB incidence. The Figure presents a map of the ZCTA-level TB incidence rates. Global Moran's *I*-test indicated the presence of significant ($P = 0.002$) spatial autocorrelation (Moran's $I = 0.42$), indicating that similar case rates clustered spatially with those in neighboring ZCTAs.

Social disadvantage

As seen in Table 1, without controlling for demographic characteristics, a socio-economic gradient was observed across SEP index quartiles, with incidence rates increasing from one SEP index quartile to the next lowest. Incidence rates in the lowest quartile (i.e., population residing in the poorest ZCTAs) were twice as high as in the wealthiest SEP index quartile. Incidence rates did not necessarily follow a monotonic trend for every SES variable, but with the exception of proportion in the working class, those living in the lowest risk factor quartile had the highest risk ratios (RR), with IRRs comparing the lowest vs. highest SES quartile varying between 1.5 and 5.

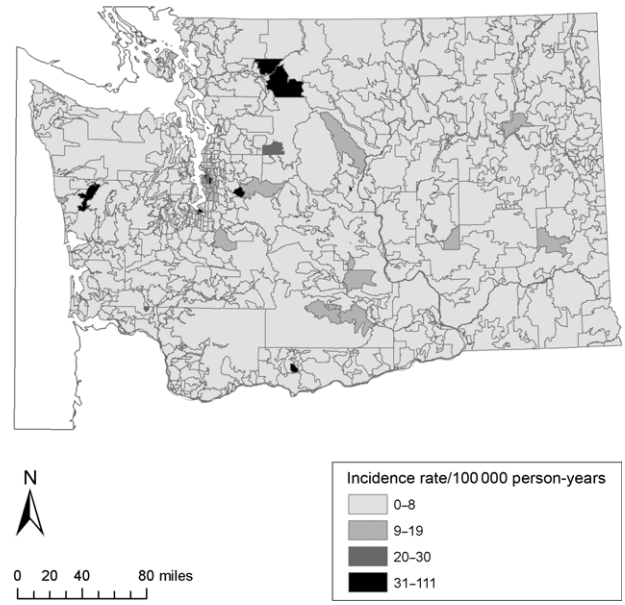

Figure Average tuberculosis incidence rates, Washington State ZCTAs, 2000–2008. ZCTA = ZIP Code tabulation area.

Multivariate associations with tuberculosis incidence

In the age- and sex-adjusted mixed-effects Poisson model, each poorer SEP quartile was associated with significantly increased risk of disease across all ZCTAs, with the poorest quartile demonstrating a 10-fold increase in risk (Table 2). Age- and sex-adjusted analyses containing ZCTA-level variables found the poorest SEP group to be associated with a more than 6-fold greater IRR of TB compared to the wealthiest SEP referent group (RR 6.2, 95% confidence interval [CI] 3.0–12.9). Introduction of ZCTA-level race and origin variables into the multivariate model attenuated the SEP-TB association. Random effect variance across ZCTAs showed a substantial decrease when area-level influences were first added. Residing in a ZCTA with a greater proportion of foreign-born, Hispanic and Black residents increased the risk of TB in adjusted analyses. The only singular SES measure to show comparably high IRRs in an age- and sex-adjusted model was home ownership.

DISCUSSION

Our study found a strong and statistically significant association between area-based indices of SEP and TB incidence, with a clear gradient of higher rates observed among lower ZCTA socio-economic quartiles. These results were consistent with other investigations that have found higher TB rates in socio-economically deprived neighborhoods in the United States,[4,6,16] and that TB risk decreases across an SES gradient.[4] SES health gradients have also been described for a number of chronic diseases, and multilevel studies have shown various disease-specific outcomes linked to community contextual effects.[9]

*The Appendix is available in the online version of this article at http://www.ingentaconnect.com/content/iuatld/ijtld/2012/00000016/00000007/art00006

Table 1 Incidence rate ratios for area-based socio-economic measures

ABSM measure	Cases *n*	Person-years*	Incidence rate/100 000	IRR (95%CI)†	*P* value‡
SEP index					
High	599	20 800 000	2.9	1.00	
Medium-high	582	13 800 000	4.2	1.46 (1.30–1.64)	
Medium-low	471	10 300 000	4.6	1.59 (1.40–1.79)	
Low	509	8 100 000	6.3	2.17 (1.93–2.45)	<0.001
Poverty, %					
0–6.7	457	18 000 000	2.5	1.00	
6.8–11.3	508	15 000 000	3.4	1.33 (1.17–1.52)	
11.4–17.7	669	12 100 000	5.5	2.18 (1.93–2.46)	
17.8–88.8	527	8 000 000	6.6	2.60 (2.29–2.96)	<0.001
Working class, %					
0–50.2	344	11 100 000	3.1	1.00	
50.3–56.4	434	12 500 000	3.5	1.12 (0.97–1.29)	
56.5–62.3	776	16 200 000	4.8	1.55 (1.36–1.76)	
62.4–100	607	13 200 000	4.6	1.48 (1.30–1.70)	<0.001
Median household income, US$					
13 393–32 558	415	6 500 000	6.4	2.20 (1.94–2.49)	
32 559–39 416	293	9 200 000	3.2	1.10 (0.95–1.26)	
39 417–48 379	792	14 700 000	5.4	1.85 (1.67–2.05)	
48 380–132 665	661	22 700 000	2.9	1.00	<0.001
House value ⩾US$300 000, %					
0–0.2	185	2 000 000	9.2	2.16 (1.83–2.53)	
2.3–3.5	535	14 700 000	3.6	0.85 (0.76–0.95)	
3.6–11.1	658	18 000 000	3.6	0.85 (0.77–0.95)	
11.2–100	783	18 300 000	4.3	1.00	0.376
Low education, %					
0–9.3	549	18 400 000	3.0	1.00	
9.4–13.8	543	16 300 000	3.3	1.12 (0.99–1.26)	
13.9–19.3	417	11 400 000	3.6	1.23 (1.08–1.39)	
19.4–100	652	6 800 000	9.5	3.19 (2.85–3.58)	<0.001
Unemployment, %					
0–2.8	317	10 900 000	2.9	1.00	
2.9–4.0	829	20 200 000	4.1	1.41 (1.24–1.61)	
4.1–5.4	588	13 800 000	4.3	1.47 (1.28–1.68)	
5.5–37.1	427	8 100 000	5.2	1.80 (1.55–2.09)	<0.001
Home ownership, %					
0–63.2	1479	21 100 000	7.0	4.85 (4.00–5.94)	
63.3–72.6	358	14 000 000	2.6	1.77 (1.43–2.21)	
72.7–80.0	213	10 300 000	2.1	1.43 (1.13–1.82)	
80.1–100	111	7 700 000	1.4	1.00	<0.001
Crowding, %					
0–2.2	261	10 100 000	2.6	1.00	
2.3–3.9	352	13 600 000	2.6	1.00 (0.85–1.18)	
4.0–6.2	557	16 100 000	3.4	1.34 (1.15–1.56)	
6.3–59.6	991	13 200 000	7.5	2.91 (2.53–3.34)	0.008

*Proportion of total population in ZCTAs in particular SES quartile over total 9-year study period.
†Obtained by comparing each socio-economic quartile group to the referent high socio-economic quartile group.
‡Linear test for trend.
ABSM = area-based socio-economic measure. IRR = incidence rate ratio; CI = confidence interval; SEP = socio-economic position; ZCTA = ZIP Code tabulation area; SES = socio-economic status.

Neighborhood environments are thought to influence disease patterns through a number of pathways, including social interaction,[17] stressors associated with resource deprivation,[18] lower access to high-quality health care and high cost of services and goods.[19] Lower SES neighborhoods may have social environments with attributes that encourage behaviors known to be risk factors for TB, such as increased interaction in crowded areas, higher rates of substance abuse, poor nutrition and smoking.[20,21]

In this study, in analyses unadjusted for demographic factors, the strongest independent area-based risk factors were living in areas with increasing crowding, lower levels of education and lower rates of home ownership. Higher household density is thought to increase the probability of TB exposure due to the greater degree of shared air space and the effective transmission of TB through small droplet nuclei.[22,23] However, while a strong association was found between TB mortality and household density in England and between higher TB rates and housing units with more persons per household in Chicago,[24,25] an association between TB incidence and neighborhood-level overcrowding has not previously been observed.[26]

Table 2 Adjusted associations of area-based socio-economic measures and tuberculosis rates using age and sex-adjusted Poisson regression models (n = 561 ZCTA)

	Model 1: unadjusted IRR (95%CI)*	Model 2: age and sex IRR (95%CI)*	Model 3: area–level covariates IRR (95%CI)*
ZCTA variance (SE)	0.89 (0.03)	1.22 (0.09)	0.78 (0.07)
SEP quartiles†			
Q2	1.8 (1.6–2.0)	2.7 (1.4–5.5)	2.3 (1.2–4.6)
Q3	2.5 (2.2–2.8)	4.1 (2.1–8.3)	2.6 (1.3–5.2)
Q4: lowest	3.4 (3.1–3.9)	10.4 (5.0–21.4)	5.7 (2.8–11.7)
P trend‡	<0.001	<0.001	<0.001
ZCTA-level variables			
Asian			
Q2			0.9 (0.5–1.4)
Q3			1.1 (0.7–1.8)
Q4			1.5 (0.9–2.6)
Black			
Q2			1.1 (0.6–1.9)
Q3			1.3 (0.7–2.5)
Q4			1.9 (1.0–3.5)
Foreign-born			
Q2			0.7 (0.4–1.3)
Q3			1.0 (0.6–1.6)
Q4			1.7 (1.0–2.9)
Hispanic			
Q2			0.9 (0.6–1.4)
Q3			1.1 (0.7–1.7)
Q4			1.8 (1.2–2.8)

*IRRs and 95%CIs reflect unit increases in SEP quartile (going from higher to lower SEP).
†Compared to the wealthiest SEP referent.
‡Obtained by including SES as an ordinal covariate in regression equations.
ZCTA = ZIP Code tabulation area; IRR = incidence rate ratio; CI = confidence interval; SE = standard error; SEP = socio-economic position; Q = quartile; SES = socio-economic status.

This suggests that airborne transmission of TB in the immediate environment may be more relevant than general measures of crowding across ZCTAs.

Controlling for ZCTA-level proportions of Asian, Black, Hispanic or foreign-born residents attenuated the SEP-TB association. Higher TB incidence rates have previously been documented in minorities,[4] and immigrants have been associated with higher incidence rates and poorer neighborhoods.[27] Higher incidence rates among the foreign-born are thought to be mostly due to reactivation of an earlier infection with decline in immunocompetence,[28] and previous research has shown high concentrations of minority groups in environmentally and economically deprived areas.[29] In our study, area-based poverty measures were strongly associated with TB after adjusting for area-based race, ethnicity and area of birth.

While the use of 2000 census measures means that area-level data and population distributions were up to a decade old, the prolonged latency period of TB makes it difficult to attribute observed disease rates to current levels of poverty; 2000 census measures could be instructive in predicting the prospective disease outcomes measured. It is possible that a previous episode of TB may reduce one's SES, but the low proportion of cases observed with previous TB (6%) suggests that the possibility of reverse causation explaining these results is likely limited. Furthermore, TB may have been under-reported, particularly on the lower end of the SES spectrum.

For the purposes of this study, SES was not measured at the individual level. Area-based SES status in the study furthermore did not take into account lifetime history of exposure, upon which an individual's risk of active disease is dependent. However, area-based inequality assessments have been shown to generate effect estimates analogous to those yielded by individual-level measures.[30] Individual-level educational and employment opportunities, as well as other demographic factors, can be partially determined by the neighborhood in which one lives. It would be of great interest to tease apart the contribution of individual-level and area-level SES, were both kinds of data available.

Strengths of this study include inclusion of community-level characteristics, control for age and sex, low proportions of missing data and a large number of area-based units included in the analysis. Surprisingly few studies have attempted to quantify the importance of SES and TB rates in low-incidence countries using robust multilevel methods. Only one case-control study could be identified,[31] and ecological studies have largely found an inverse association between SES level and TB incidence.[4,5] In South Africa and Brazil, prevalence and risk of active TB were associated with individual-, household- and community-level SES.[27,31] The current study indicated that TB incidence rates in one ZCTA tended to be similar to proximal neighboring values. As previous findings have shown the detrimental impact of relative poverty on individual health,[32] these results merit further research to determine the impact of neighboring SES on incidence in a particular area.

CONCLUSIONS

This study supports the hypothesis that socio-economic deprivation contributes to neighborhood differences in TB incidence, at least in Washington State. Both SEP index and singular-community SES exposures performed well in distinguishing ZCTAs with high TB incidence rates from those with little TB. While improvements in effective identification and interruption of ongoing TB transmission are important, additional emphasis to improve neighborhood SES standing (reduction of overcrowding, improvements in education) may provide a complementary approach to reaching the TB elimination goals set by the Institute of Medicine (Washington DC, USA).[33] Further research across multiple communities could jointly investigate additional factors at both the individual and community levels. As SES did not explain a high proportion of the variation in TB rates, other factors likely contribute to TB. Based on these findings it would be of interest to understand whether TB transmission

dynamics are more heavily influenced by airborne transmission of TB in the immediate environment or by general measures of crowding across larger areas.

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APPENDIX

Table A1 Characteristics of 2161 TB cases in Washington State, 2000–2008*

	n (%)†	Washington State 2000 population *n* (%)‡	Incidence/100 000 person-years§
Total	2 161 (100.0)	5 894 121 (100)	4.1
Sex			
Male	1 270 (58.8)	2 934 300 (49.8)	4.8
Female	891 (41.1)	2 959 821 (51.2)	3.4
Unknown	1 (0.1)	NA	
Median diagnosis age, years	42.0	35.3	NA
0–4	53 (2.5)	394 306 (6.7)	1.5
5–14	49 (2.3)	860 745 (14.6)	0.6
15–24	299 (13.8)	818 153 (13.9)	4.1
25–44	749 (34.7)	1 816 217 (30.8)	4.6
25–64	577 (26.7)	1 342 552 (22.8)	4.8
⩾65	434 (20.1)	662 148 (11.2)	7.3
Race			
American Indian	103 (4.8)	93 301 (1.6)	12.3
Asian	874 (40.4)	322 335 (5.5)	30.1
Black	389 (18.0)	190 406 (3.2)	22.7
Native Hawaiian	46 (2.1)	23 953 (0.4)	21.3
White	733 (33.9)	4 821 823 (81.8)	1.7
Multiple races	5 (0.2)	213 519 (3.6)	0.3
Unknown	11 (0.5)	NA	
Ethnicity			
Hispanic¶	328 (15.2)	441 509 (7.5)	8.3
Non-Hispanic	1 823 (84.3)	5 452 612 (92.5)	3.7
Missing or unknown	10 (0.5)	NA	
Country of origin			
US-born	623 (28.8)	5 279 664 (89.6)	1.3
Foreign-born#	1 534 (71.0)	614 457 (10.4)	27.7
Urbanization			
Urban	322 (56.2)	4 831 106 (82.0)	6.7
Rural	241 (42.1)	1 063 015 (18.0)	22.7
Missing	10 (1.8)	NA	
Time from US arrival to TB diagnosis, years**		NA	
0–4	586 (38.2)		
5–9	258 (16.8)		
10–19	323 (21.1)		
⩾20	255 (16.8)		
Missing	112 (7.3)		
HIV status		NA	
Positive	93 (4.3)		
Negative	1 556 (72.0)		
Indeterminate	1 (0.1)		
Refused	161 (7.5)		
Not offered	282 (13.1)		
Unknown or missing	68 (3.1)		
Previous TB disease		NA	
No	1 983 (91.8)		
Yes	133 (6.2)		
Unknown	45 (2.1)		
Site of disease		NA	
Pulmonary	1 302 (60.3)		
Extra-pulmonary	602 (27.9)		
Both	257 (11.9)		

*Excludes 56 cases that do not match a 2000 ZCTA or lack a ZIP Code.
†Percentages may not total 100 due to rounding.
‡Washington data source: US Census 2000.
§Person-year incidence rate denominators calculated by multiplying 2000 denominator estimates by 9-year study period.
¶As per US TB guidelines, ethnicity is coded separately from race; persons of Hispanic ethnicity may therefore be of any or multiple race.
#Includes persons born outside the United States, American Samoa, the Federated States of Micronesia, Guam, the Republic of the Marshall Islands, Midway Island, the Commonwealth of the Northern Mariana Islands, Puerto Rico, the Republic of Palau, the US Virgin Islands, and US minor and outlying Pacific islands.
**Among foreign-born patients.
TB = tuberculosis; NA = not available; HIV = human immunodeficiency virus; ZCTA = ZIP Code tabulation area.

Table A2 Characteristics of 569 ZCTA included in the analysis, based on 2000 US Census data*

Demographic variables	Median	Mean	SD	IQR	Range, %
Population size, *n*	3822	10359	12556	732–19156	3–64214
Male, %	50.0	50.7	5.0	49.1–51.3	0–100
Age, years	35.3	37.5	6.5		13.5–68.9
Race, %					
White	90.0	84.6	15.8	81.8–94.0	0–100
Asian	0.9	2.6	4.4	0.4–2.8	0–43
Black	0.4	1.9	5.6	0.1–13.7	0–100
American Indian/Alaskan Native	1.2	3.5	10.9	0.8–1.9	0–100
Native Hawaiian and Pacific Islander	0.1	0.2	0.4	0–0.2	0–3
Hispanic ethnicity	3.6	7.5	11.8	2.1–6.6	0–73
Foreign-born†	4.6	7.4	8.2	2.2–9.9	0–52
Socio-economic variables, %					
Below poverty	11.3	13.2	9.2	6.7–17.7	0–89
Working class	56.4	55.9	11.2	50.2–62.3	0–100
Household income, US$	39416	41521	13227	32558–48379	13393–132665
House value ⩾$300000	3.5	9.9	16.8	0–11.1	0–100
Less than high school education	13.8	15.6	10.5	9.3–19.3	0–100
Unemployment	4.0	4.6	3.5	2.8–5.4	0–37
Home ownership	72.6	70.0	16.5	63.2–80.0	0–100
Overcrowding	3.9	5.4	6.0	2.2–6.2	0–60
Tuberculosis measures					
Case count sum (2000–2008), *n*	0	3.8	10.2	0–3.0	0–127
Mean case count/year, *n*‡	0	0.4	1.1	0–0.3	0–14.1
Mean incidence (per 100000 person-years)‡	0	4.0	15.6	0–3.2	0–110.6

*Prior to analysis 14 ZCTAs with no population were excluded (water features).
†Excludes birth in a US territory or birth abroad to American parents.
‡Person-years at risk estimated by multiplying the 2000 ZCTA population by nine.
ZCTA = ZIP Code tabulation area; SD = standard deviation; IQR = interquartile range.

RÉSUMÉ

OBJECTIF : Examiner les influences du voisinage sur l'incidence de la tuberculose (TB) dans un échantillon basé sur des niveaux multiples de la population.

SCHÉMA : On a identifié tous les cas incidents de TB déclarés entre le 1er janvier 2000 et le 31 décembre 2008 dans l'Etat de Washington aux Etats-Unis (n = 2161). Une analyse multivariée de Poisson a été utilisée au niveau de la zone de tabulation ZIP Code (ZCTA), ce qui a permis une exploration complémentaire des influences spécifiques aux zones sur l'incidence de la TB.

RÉSULTATS : On a trouvé une association significative entre les indices de situation socio-économique (SEP) et l'incidence de la TB dans l'Etat de Washington, avec un gradient net de taux plus élevés parmi les quartiles socio-économiques (ZCTA) les plus bas. Par comparaison avec le quartile SEP le plus riche, l'incidence relative de la TB dans les quartiles de plus en plus bas a été de 2,7 ; 4,1 et 10,4 respectivement (P pour la tendance $< 0,001$). Dans les analyses multivariées, l'association est atténuée par l'adjonction de la race au niveau de la zone, de l'ethnie et du pays de naissance (ratios de taux d'incidence ajusté : 2,3 ; 2,6 et 5,7 ; P pour la tendance $<$ 0,001).

CONCLUSION : Cette étude a mis en évidence une association significative et inverse entre les mesures de statut socio-économique (SES) dans des zones et l'incidence de la TB dans divers ZCTA dans l'Etat de Washington même après ajustement pour l'âge et le sexe individuels, la race, l'ethnie et la naissance à l'étranger dans la zone. Ces résultats insistent sur l'importance du contexte de voisinage et sur la nécessité de cibler les efforts de prévention dans les environnements dont le SES est faible.

RESUMEN

OBJETIVO: Investigar las influencias de factores de la vecindad sobre la incidencia de tuberculosis (TB) mediante un análisis logístico de escala múltiple de una muestra poblacional.

MÉTODOS: Se detectaron todos los casos nuevos de TB notificados en el estado de Washington en los Estados Unidos, entre el 1° de enero del 2000 y el 31 de diciembre del 2008. Se aplicó un análisis multifactorial de Poisson a escala de la zona de tabulación del código postal (ZCTA), con lo cual se facilitó la investigación de las influencias específicas de la zona en la incidencia de TB.

RESULTADOS: Se observó una asociación significativa entre los índices de posición de socioeconómica (SEP) y la incidencia de TB en el estado de Washington, con un claro gradiente de tasas más altas en los cuartiles socioeconómicos más bajos de la ZCTA. Comparados con el cuartil más solvente del índice SEP, la incidencia relativa de TB en los cuartiles inferiores sucesivos fue 2,7; 4,1 y 10,4 respectivamente (P de la tendencia $< 0,001$). En los análisis multifactoriales, la adición de variables a escala de la zona con respecto a la raza, la etnia y el país de nacimiento atenuó esta asociación de manera significativa (razón de la tasa de incidencia ajustada: 2,3; 2,6 y 5,7; P de la tendencia $< 0,001$).

CONCLUSIÓN: En el presente estudio se encontró una relación inversa significativa entre los índices de situación socioeconómica (SES) de la vecindad y la incidencia de TB en las diversas ZCTA en el estado de Washington, incluso tras corregir con respecto a las características individuales de edad y sexo y las características de la zona en materia de raza, etnia y nacimiento en el extranjero. Estos resultados destacan la importancia del contexto del vecindario y la necesidad de dirigir las intervenciones de prevención a las comunidades con una SES desfavorable.