Published in final edited form as:

Int J Tuberc Lung Dis. 2017 April 01; 21(4): 425–431. doi:10.5588/ijtld.16.0434.

***Mycobacterium tuberculosis* infection among persons who inject drugs in San Diego, California**

R. F. Armenta^{*}, K. M. Collins[†], S. A. Strathdee[‡], M. A. Bulterys[†], F. Munoz[†], J. Cuevas-Mota[†], P. Chiles[‡], and R. S. Garfein[†]

^{*} Division of Epidemiology, Department of Family Medicine and Public Health, University of California San Diego, San Diego

[†] Division of Global Public Health, Department of Medicine, University of California San Diego, San Diego

[‡] Division of Pulmonology, Critical Care and Sleep Medicine, Department of Medicine, University of California San Diego, San Diego, California, USA

SUMMARY

BACKGROUND: Persons who inject drugs (PWID) might be at increased risk for *Mycobacterium tuberculosis* infection and reactivation of latent tuberculous infection (LTBI) due to their injection drug use.

OBJECTIVES: To determine prevalence and correlates of *M. tuberculosis* infection among PWID in San Diego, California, USA.

METHODS: PWID aged ≥ 18 years underwent standardized interviews and serologic testing using an interferon-gamma release assay (IGRA) for LTBI and rapid point-of-care assays for human immunodeficiency virus (HIV) and hepatitis C virus (HCV) infections. Independent correlates of *M. tuberculosis* infection were identified using multivariable log-binomial regression.

RESULTS: A total of 500 participants met the eligibility criteria. The mean age was 43.2 years (standard deviation 11.6); most subjects were White (52%) or Hispanic (30.8%), and male (75%). Overall, 86.7% reported having ever traveled to Mexico. Prevalence of *M. tuberculosis* infection was 23.6%; 0.8% were co-infected with HIV and 81.7% were co-infected with HCV. Almost all participants (95%) had been previously tested for *M. tuberculosis*; 7.6% had been previously told they were infected. *M. tuberculosis* infection was independently associated with being Hispanic, having longer injection histories, testing HCV-positive, and correctly reporting that people with ‘sleeping’ TB cannot infect others.

CONCLUSIONS: Strategies are needed to increase awareness about and treatment for *M. tuberculosis* infection among PWID in the US/Mexico border region.

Correspondence to: Richard S Garfein, Division of Global Public Health, Department of Medicine, School of Medicine, University of California, San Diego, 9500 Gilman Drive, MC-0507 San Diego, CA 92093-0507, USA. rgarfein@ucsd.edu.

Conflict of interest: none declared.

Disclaimer: NIDA had no role in study design, data collection, data analysis, interpretation of data, or writing of this manuscript.

RESUME

Les utilisateurs de drogues injectables (PWID) pourraient avoir un risque accru d'infection à *Mycobacterium tuberculosis* et de réactivation d'une infection tuberculeuse latente (LTBI) en raison de leur usage de drogues.

Déterminer la prévalence et les corrélations de l'infection à *M. tuberculosis* parmi les PWID à San Diego, Californie, Etats Unis.

Des PWID âgés de 18 ans ont participé à des entretiens standardisés et ont eu des tests sérologiques à la recherche d'une LTBI grâce à un test de libération de l'interféron gamma et des tests rapides sur place à la recherche d'infections par les virus de l'immunodéficience humaine (VIH) et de l'hépatite C (HCV). Des corrélations indépendantes de l'infection à *M. tuberculosis* ont été identifiées grâce à une régression multivariée log-binomiale.

Au total, 500 participants ont répondu aux critères d'éligibilité. Leur âge moyen a été de 43,2 ans (déviations standard 11,6), la majorité était de race blanche (52%) ou hispanique (30,8%) et de sexe masculin (75%); 86,7% déclaraient avoir voyagé au Mexique au moins une fois. La prévalence de l'infection à *M. tuberculosis* a été de 23,6%; 0,8% étaient co-infectés par le VIH et 81,7% étaient co-infectés par le HCV. Presque tous les participants (95%) avaient déjà été testés à la recherche de *M. tuberculosis*; 7,6% avaient été informés de leur infection. L'infection à *M. tuberculosis* a été indépendamment associée au fait d'être Hispanique, d'avoir un long passé d'injections, d'avoir un test positif au HCV et de savoir que les personnes atteintes de LTBI n'étaient pas contagieuses.

Des stratégies sont requises afin d'augmenter la prise de conscience des PWID et le traitement de l'infection à *M. tuberculosis* parmi les PWID dans la région des Etats-Unis proche de la frontière mexicaine.

RESUMEN

Es posible que personas que consumen drogas inyectables (PWID) sean más vulnerables a la infección por *Mycobacterium tuberculosis* y a la reactivación de la infección tuberculosa latente (LTBI), debido a este consumo.

Determinar la prevalencia de infección por *M. tuberculosis* y sus factores correlacionados en los PWID en San Diego, California.

Se realizaron entrevistas normalizadas a PWID de edad de 18 años o mayores, pruebas serológicas de liberación de interferón γ con el fin de diagnosticar la LTBI y análisis diagnósticos inmediatos de la infección por el virus de la inmunodeficiencia humana (VIH) y el virus de la hepatitis C (VHC). Mediante modelos de regresión logarítmica binomial se definieron las variables independientes asociadas con la infección tuberculosa.

Quinientas personas cumplieron con los criterios de selección. El promedio de edad fue 43,2 años (desviación estándar 11,6), la mayoría de participantes era de etnia blanca (52%) o latina (30,8%) y de sexo masculino (75%). En general, el 86,7% refirió un antecedente de viaje a México. La prevalencia de infección por *M. tuberculosis* fue 23,6%; se observó un 0,8% de coinfección por el VIH y un 81,7% de coinfección por el VHC. En casi todos los participantes (95%) se había investigado la infección tuberculosa y al 7,6% se había comunicado un resultado positivo. La infección tuberculosa se asoció de manera independiente con el hecho de ser de origen hispánico, presentar un antecedente de consumo de drogas inyectables más prolongado, obtener un resultado

positivo frente al VHC y responder de manera correcta que las personas aquejadas de LTBI no son contagiosas.

Es necesario introducir estrategias que mejoren los conocimientos sobre la infección tuberculosa y su tratamiento en las PWID en la zona fronteriza entre los Estados Unidos y México.

Keywords

injection drug use; HIV; QuantiFER-ON®-TB Gold In-Tube assay; latent tuberculous infection; PWID

APPROXIMATELY one-third of the world's population is infected with *Mycobacterium tuberculosis*, and tuberculosis (TB) remains the leading cause of death among human immunodeficiency virus (HIV) positive individuals.¹ In the United States, TB primarily affects foreign-born residents; however, certain subgroups are at increased risk for infection. ¹ Globally, the prevalence of latent tuberculous infection (LTBI) among persons who inject drugs (PWID) has been estimated at between 10% and 67%; studies among PWID in Tijuana, Baja California, Mexico, have found a prevalence of 55–67%, distinguishing PWID as one of the leading populations at risk for LTBI.^{2–4}

LTBI is asymptomatic and non-infectious, but has a 10% lifetime risk of reactivating in otherwise healthy individuals; for those co-infected with HIV, the lifetime risk of LTBI reactivation is significantly higher, at 7–10% per year.⁵ In its latent state, *M. tuberculosis* infection is diagnosed using the tuberculin skin test (TST) or an interferon-gamma release assay (IGRA). Injecting drugs may increase risk for *M. tuberculosis* infection due to individual, structural, and social factors related to illicit drug use.^{6,7} A review of published studies examining factors associated with TB among PWID suggests that susceptibility to infection increases for those living in low-income areas with limited access to health care, overcrowded housing conditions or injecting in crowded spaces such as shooting galleries and homeless shelters⁸ that facilitate TB transmission, and poor adherence to anti-tuberculosis treatment within the community, all of which are also commonly associated with injection drug use (IDU).³

San Diego County shares the busiest land border crossing in the world with Tijuana, where approximately 59 million crossings took place in 2014; together they form the largest metropolitan area along the US/Mexico border.⁹ The region is situated along a major drug trafficking route, and illicit drugs such as heroin, cocaine, and methamphetamine are readily available in San Diego and Tijuana.¹⁰ PWID are often a mobile population in search of work, shelter, and illicit substances.^{2,10} PWID who live in San Diego can readily travel to Mexico to purchase, use, and inject drugs. In 2011, 27% of PWID in San Diego reported ever having injected drugs in Tijuana.¹⁰

The prevalence of *M. tuberculosis* is much higher among PWID in Tijuana (67%) than San Diego (27%).^{4,11} Baja California has the highest incidence of pulmonary TB nationally (54.4 cases per 100 000 population), three times Mexico's national average.¹² This may partly explain why the rate of *M. tuberculosis* in California is nearly double that of the

United States (5.6 vs. 2.9/100 000).¹³ The ongoing bi-directional movement of people across the US/ Mexico border increases the potential for cross-border spread of disease.¹⁴

Prevalence estimates and factors associated with *M. tuberculosis* infection among PWID in San Diego are unknown, although elsewhere in the United States the prevalence among PWID has been estimated at 15–39%.³

The purpose of the present study was to estimate the prevalence of *M. tuberculosis* infection and identify factors associated with infection among PWID in San Diego County.

METHODS

Study population and recruitment

Between June 2012 and January 2014, PWID were recruited into the Study of Tuberculosis, AIDS and Hepatitis C Risk (STAHr-II), a longitudinal cohort study conducted in San Diego. Study methods have been described in detail elsewhere.¹⁵ Baseline data were used for this cross-sectional analysis. In brief, eligibility criteria for STAHr-II included 1) age 18 years, 2) illicit drugs injected within the past 30 days, 3) no plans to move from San Diego County in the 2 years following enrollment, 4) willingness to provide contact information, and 5) willingness to be serologically tested for HIV, HCV and *M. tuberculosis* infections. PWID were recruited using targeted advertising, street outreach, and word-of-mouth referrals from high drug-use neighborhoods throughout the county.

The University of California, San Diego, institutional review board approved this study.

Data collection and study measures

Surveys were conducted using computer-assisted personal interviewing (CAPI) to minimize errors in data collection. Trained interviewers administered questionnaires in English or Spanish, depending on participant preference, and entered responses into a laptop. Interviews assessed sociodemographic information (age, sex, race/ethnicity), history of substance use (age at first injection, type of drug used ever and in the past 6 months), route of drug administration (snorting, smoking, injecting), contextual factors (locations of drug use, travel to Mexico, syringe exchange program [SEP] use, and history of drug treatment and incarceration), and health status (e.g., health care utilization). Knowledge of and attitudes to TB were measured using items about how TB is transmitted and treated. All behavioral questions were assessed as lifetime and during the 6 months before enrollment. After the interview, participants received pre-test counseling, followed by HIV, HCV, and *M. tuberculosis* testing. Participants were compensated with USD25 for the baseline visit.

Laboratory testing

M. tuberculosis infection was assessed using the QuantiFERON®-TB Gold In-Tube assay (QFT-GIT; Qiagen, Hilden, Germany), with the results interpreted according to the manufacturer's package insert. QFT-GIT is an in vitro assay that detects *M. tuberculosis* infection, but cannot differentiate between active disease and latent infection; participants who tested QFT-positive were thus referred to local public health clinics for follow-up

testing to rule out active disease. Those who tested QFT-positive were considered to have *M. tuberculosis* infection. Indeterminate test results were excluded from this analysis.

HIV and HCV testing were performed using routine procedures described elsewhere.¹⁵ Briefly, HIV testing was conducted using the HIV Unigold Recombigen rapid antibody test (Trinity Biotech PLC, Bray, Ireland), and all participants testing positive underwent confirmatory Western blot testing. HCV testing was conducted using the OraQuick HCV rapid antibody test (Orasure Technologies Inc, Bethlehem, PA, USA). Confirmatory HCV testing was not performed given the high cost and high prevalence of HCV among PWID. Post-test counseling was provided immediately after rapid HIV and HCV antibody testing. Participants returned 3 weeks after testing to receive post-test counseling, QFT test results, and confirmatory HIV testing when indicated. Individuals testing positive for any infection were given referrals for clinical evaluation. All participants were offered risk-reduction materials and referrals for drug treatment and other services. Participants received USD10 for completing their results visit.

Statistical analysis

The outcome for this analysis was QFT status. To identify differences between QFT-positive and QFT-negative participants, we used *t*-tests or Wilcoxon sign-rank tests for continuous variables and χ^2 tests for categorical variables. Given the high prevalence of *M. tuberculosis* infection, log-binomial regression was conducted to calculate prevalence ratios. Bivariate log-binomial regression models were used to examine the associations between covariates and QFT status to select variables for inclusion in multivariable analysis. Multivariable log-binomial regression was used to identify factors independently associated with QFT status. Variables that were significant at the $\alpha = 0.20$ level in bivariate analyses were considered for inclusion in multivariable models. Forward stepwise logistic regression was performed manually, and variables significant at the $\alpha = 0.05$ level using the likelihood ratio statistic were retained in the final model. Confounders were assessed by determining significant changes (i.e., >10%) between crude and adjusted odds ratios, and were retained in the final model. Collinearity was assessed using variance inflation factors and condition indices.

RESULTS

Overall, 504 of the 576 (87.5%) participants enrolled in STAHR-II had QFT results; two were missing assessment data and two had indeterminate results, leaving 500 participants included in this analysis. Demographic factors were similar for participants included and excluded (data not shown; all *P* values > 0.05). The majority of the participants were White (52%) or Hispanic (30.8%), and male (75%), with a mean age of 43 years (standard deviation 11.6, range 18–80). Monthly income was low, with 69% of participants reporting a yearly income of <USD\$10 000. Almost all (97%) participants were born in the United States and had lived in San Diego for a mean of 25 years; 87% had ever traveled to Mexico.

The prevalence of *M. tuberculosis* infection was 23.6% (*n* = 118). Previous *M. tuberculosis* testing was common, with 95% having ever been tested. Only 37 (7.6%) had previously been told they were infected with *M. tuberculosis*, and the majority (81.1%) also tested positive for *M. tuberculosis* in this study. Knowledge of TB was generally low, with only

67.7% of participants correctly reporting that people can have a TB germ in their body that is ‘sleeping’ and not active, and only 43.5% correctly indicating that people with sleeping TB cannot infect others. Approximately half (52.4%) of the participants correctly reported that TB can be spread through sharing dishes, bottles, or toothbrushes, and 77% correctly indicated that TB could be spread through the air. Only 65.9% of participants knew that there are medications available to treat TB.

In bivariate analysis (Table 1), compared to those who were QFT-negative, QFT-positive participants were more likely to be older (mean age 47.1 vs. 42.1 years), Hispanic (44.2% vs. 26.7%), to have lived in San Diego longer (29.6 vs. 24.6 years), to have ever been in prison (59.5% vs. 49.2%), and to have ever traveled to Mexico (91.5% vs. 85.3%). When assessing substance abuse-related behaviors, QFT positivity was associated with longer history of IDU (mean 25.2 vs. 19.2 years; all *P* values <0.05).

QFT-positive participants were less likely to be HIV-positive (3.3% vs. 11.9%), but more likely to be HCV antibody-positive (81.7% vs. 60.2%). QFT positivity was also associated with ever having been told by a health professional that they had LTBI (26.3% vs. 1.9%) or TB disease (6.9% vs. 3.2%). Those who were QFT-positive were more likely to correctly report that people can have ‘sleeping’ TB (78.8% vs. 64.2%) and that people with sleeping TB cannot infect others (51.7% vs. 40.9%; Table 2).

In the multivariable analysis, QFT positivity was independently associated with being Hispanic, being HCV antibody-positive, and having a longer injection career. Being QFT-positive was inversely associated with testing HIV-positive (Table 3).

DISCUSSION

Approximately one quarter of PWID in the study were infected with *M. tuberculosis*. QFT-positive PWID were more likely to be Hispanic, have a longer injection career, be HCV-positive, and report that people with LTBI cannot infect others; they were less likely to be HIV-positive.

The prevalence of *M. tuberculosis* infection in the study was considerably lower than estimates of *M. tuberculosis* infection among PWID in Tijuana, Baja California, which reported an LTBI prevalence of 55–67%,⁴ but much higher than in the general population of San Diego (6.9 cases/100 000).¹⁶ However, it was consistent with other studies among PWID living in similar settings in San Francisco (CA, USA), Baltimore (MD, USA), Taiwan, Canada, and Puerto Rico, which reported prevalences of 18–59%.^{17–21}

M. tuberculosis infection was associated with being HCV-positive. Other studies have found an increased prevalence of HCV infection among individuals with active TB.²² This association could result from those being HCV-positive having a longer injection career and more injection partners.²³ Although we controlled for duration of injecting, other factors could have increased the risk of exposure to TB. For example, injection-related risk factors such as the number of injection partners, or the use of shooting galleries or other cramped spaces to inject drugs (both of which may be increased in longer career injectors) may increase the risk of infection.^{4,17} LTBI has been found to be associated with a longer

injection career in Tijuana, Mexico, and Montreal, QC, Canada.^{4,17} The environmental and risk behaviors related to long-term drug abuse may contribute to increased prevalence and incidence of *M. tuberculosis* infection and HCV among PWID. We did not observe direct associations between *M. tuberculosis* infection and these risk factors in our study, but this could be because participants reported having few injection partners (mean 2.2), and only five participants reported regular use of shooting galleries.

Somewhat paradoxically, HIV prevalence was lower among PWID who were QFT-positive, but others have reported similar findings.^{17,24} Other studies used TST, which is known to have reduced sensitivity among individuals with HIV due to immunosuppression. The current study used QFT, which has greater sensitivity than TST among individuals with HIV and produces indeterminate—rather than negative—results if the subject is severely immunosuppressed.²⁵ Only two participants were QFT-indeterminate in this study, and both were HIV-negative. Furthermore, the case-fatality rate for TB is higher among those who are HIV-positive;^{26,27} our findings may thus have been affected by differential survival.

M. tuberculosis infection continues to pose a significant public health threat, and PWID appear to be at increased risk for infection. Better prevention messages and increased screening is needed for PWID, especially those who are HIV-infected, as their risk of developing active *M. tuberculosis* infection is higher.²⁸ Previous studies have found that among PWID with TB, at least one third are also infected with HIV and two thirds are infected with HCV.²⁹ Earlier initiation of antiretroviral therapy is recommended to prevent mortality among those who are co-infected.^{26,30} Furthermore, among those who are *M. tuberculosis* and HCV co-infected, treatment-related issues and hepatotoxicity are recognized sequelae of anti-tuberculosis medications.³¹

In our sample, 37 (7.6%) participants reported having previously tested positive for *M. tuberculosis* infection, and 22 (59.5%) of these had ever taken medications to treat their infection. While the majority of the participants had ever been tested for TB, PWID continue to face significant barriers to *M. tuberculosis* testing, including limited access to health care and transportation.³ It is unclear whether current programs are effective at treating those most at risk for reactivation or developing complications from their infection. The World Health Organization (WHO) recommends integrated testing and care for TB, HIV and HCV to address structural barriers associated with testing and treatment.³² Given the risk of HIV infection among PWID, testing and treatment are vital to control the spread of TB. This is especially important given San Diego's position on the busiest land border crossing in the world and its high population mobility.

Several limitations should be considered when interpreting these findings. We were limited in our ability to assess temporal associations with LTBI due to the cross-sectional design of our analysis; our findings should thus be interpreted as markers of infection rather than risk factors for exposure. Results are based on IGRA testing alone and do not assess active disease; however, IGRAs are more sensitive and specific at detecting LTBI than TST.³³ There is no gold standard for LTBI detection, but IGRAs have been shown to have good reproducibility qualitatively, although false conversion and reversions have been reported when a standard cut-off value is used.^{33–35} Confirmatory testing was not conducted for

HCV; our HCV prevalence may thus have been overestimated. Our reliance on self-reported lifetime and past 6 months behaviors may introduce recall bias into our study; however, such misclassification is expected to be non-differential and would thus result in biasing the observed associations toward the null hypothesis. As this was a community-based sample, we would expect the prevalence of active TB to be low. We did not utilize snowball sampling, and eligibility was limited to those planning on living in San Diego for at least 2 years, which may limit our generalizability and underestimate some high-risk behaviors, such as travel to Mexico. However, we would expect this to bias our associations toward the null.

CONCLUSION

PWID appear to be at increased risk for *M. tuberculosis* infection. Testing and treating PWID for *M. tuberculosis* infection is crucial for reducing incidence and preventing further transmission of TB. This is particularly important for a population that has limited access to health care and might remain infectious for a longer period of time before receiving treatment. We found that 95% of PWID had been previously tested for *M. tuberculosis* infection, suggesting that TB testing programs have been effective. However, the prevalence of *M. tuberculosis* infection among PWID was higher than in the general population, and knowledge about risk factors for transmission was generally low. Education about risk factors for *M. tuberculosis* infection and availability of treatment, in addition to the integration of HIV and TB counseling and testing among high-risk populations, are important to prevent the future spread of disease. This is especially true for those at risk for *M. tuberculosis* and HIV co-infection, such as PWID, as their risk of LTBI reactivation is greatly increased. Our findings underscore the need for vigilant *M. tuberculosis* screening and treatment for high-risk populations to prevent the spread of TB among PWID in the US/Mexico border region.

Acknowledgements

The authors wish to thank the participants, community collaborators, and the community advisory board for their support and guidance in conducting the study.

Funding for the study was provided by a National Institutes of Drug Abuse (NIDA) grant, R01 DA031074 (PI: RSG). RFA received support from NIDA diversity supplement R01 DA031074-01S1 and a University of California Presidents dissertation year fellowship. SSA received funding from R37 DA019829.

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Bivariate analysis of factors associated with *Mycobacterium tuberculosis* infection among persons who inject drugs in San Diego, CA, USA ($n = 500$)

Table 1

	Total n (%)	QFT+ n (%)	QFT- n (%)	Prevalence ratio (95%CI)	P value
Total	500	118 (23.6)	382 (76.4)		
Sociodemographic factors					
Age, 5-year increase, mean $\pm$ SD	43.2 $\pm$ 11.6	47.1 $\pm$ 11.6	42.1 $\pm$ 11.4	1.17 (1.09–1.26)	<0.001
Sex					0.12
Male	373 (74.6)	93 (78.8)	280 (73.3)	—	
Female	121 (24.2)	25 (21.2)	96 (25.1)	0.83 (0.56–1.22)	
Transgender	6 (1.2)	0	6 (1.6)	—	
Race/ethnicity					<0.01
White	260 (52.0)	46 (39.0)	214 (56.0)	—	
Hispanic	154 (30.8)	52 (44.2)	102 (26.7)	1.91 (1.35–2.69)	
Black	42 (8.4)	10 (8.5)	32 (8.4)	1.35 (0.73–2.45)	
Other	44 (8.8)	10 (8.5)	34 (8.9)	1.28 (0.70–2.35)	
Annual income, <USD\$10 000 (reference: USD\$10 000)	344 (68.8)	84 (71.2)	260 (68.1)	1.12 (0.79–1.59)	0.52
Relationship status, single (reference: partnered)	444 (88.8)	104 (88.1)	340 (89.0)	0.94 (0.58–1.52)	0.79
Educational attainment					0.63
<High school	169 (33.8)	44 (37.3)	125 (32.7)	1.13 (0.76–1.65)	
High school	151 (30.2)	35 (29.7)	116 (30.4)	0.93 (0.62–1.40)	
>High school	180 (36.0)	39 (33.1)	141 (36.9)	—	
Housing status, homeless (reference: housed)	311 (62.2)	68 (57.6)	243 (63.6)	0.83 (0.60–1.14)	0.24
Country of birth (US vs. Mexico)	468 (97.5)	107 (96.4)	361 (97.8)	1.46 (0.64–3.30)	0.40
Years lived in San Diego, 10-year increase, mean $\pm$ SD	25.8 $\pm$ 17.2	29.6 $\pm$ 18.5	24.6 $\pm$ 16.6	1.14 (1.04–1.25)	<0.01
Ever been in prison	256 (51.6)	69 (59.5)	187 (49.2)	1.38 (0.99–1.91)	0.05
Ever traveled to Mexico	431 (86.7)	107 (91.5)	324 (85.3)	1.64 (0.90–2.97)	0.07
Substance abuse-related factors					
Number of years injecting, per 5-year increase, mean $\pm$ SD	20.6 $\pm$ 13.3	25.2 $\pm$ 13.2	19.2 $\pm$ 13.0	1.13 (1.07–1.19)	<0.001
Number of persons injected within last 6 months, mean $\pm$ SD ($n = 496$)	2.2 $\pm$ 2.7	2.1 $\pm$ 1.9	2.2 $\pm$ 2.9	0.99 (0.93–1.05)	0.78
Health care utilization, health status, and health beliefs					
Had any form of health insurance, last 6 months	255 (51.3)	65 (55.1)	190 (50.1)	1.16 (0.84–1.59)	0.36

	Total n (%)	QFT+ n (%)	QFT- n (%)	Prevalence ratio (95%CI)	P value
Ever had a skin test for TB	473 (95.0)	112 (94.9)	361 (95.0)	0.99 (0.48–2.02)	0.97
Ever had a blood test for TB	125 (25.2)	34 (28.8)	91 (24.0)	1.20 (0.85–1.69)	0.30
Ever been told they have LTBI	37 (7.6)	30 (26.3)	7 (1.9)	4.31 (3.37–5.53)	<0.001
Ever been told they have active TB	20 (4.1)	8 (6.9)	12 (3.2)	1.74 (0.99–3.05)	0.09
1 emergency room visits last 6 months (reference: none)	178 (35.7)	43 (36.8)	135 (35.3)	1.05 (0.75–1.45)	0.78
1 hospital visits last 6 months (reference: none)	87 (17.4)	24 (20.5)	63 (16.5)	1.22 (0.83–1.79)	0.32
HIV-positive (reference: HIV-negative)	49 (9.8)	4 (3.3)	45 (11.9)	0.32 (0.12–0.82)	0.10
HCV-positive (reference: HCV-negative)	325 (65.4)	98 (81.7)	227 (60.2)	2.36 (1.54–3.60)	<0.001
Current smoker (reference: former/never smoker)	424 (93.6)	103 (95.4)	321 (93.0)	1.41 (0.62–3.18)	0.37

QFT=QuantiFERON®-TB Gold In-Tube; + = positive; – = negative; CI = confidence interval. SD = standard deviation; TB = tuberculosis; LTBI = latent tuberculous infection; HIV = human immunodeficiency virus; HCV = hepatitis C virus.

TB knowledge and attitudes associated with *Mycobacterium tuberculosis* infection among persons who inject drugs in San Diego, CA, USA ($n = 500$)

	Total <i>n</i> (%)	QFT+ <i>n</i> (%)	QFT- <i>n</i> (%)	Prevalence ratio (95%CI)	<i>P</i> value
Total	500	118 (23.6)	382 (76.4)		<0.001
People with sleeping TB can infect others? (no vs. yes)	216 (43.5)	61 (51.7)	155 (40.9)	1.39 (1.02–1.91)	0.04
TB can be spread through sharing dishes, bottles, or toothbrush? (no vs. yes)	261 (52.4)	66 (55.9)	195 (51.3)	1.15 (0.83–1.58)	0.38
TB can be spread through the air? (yes vs. no)	387 (77.7)	89 (75.4)	298 (78.4)	0.88 (0.61–1.26)	0.49
TB can be cured by medicine? (yes vs. no)	328 (65.9)	86 (72.9)	242 (63.7)	1.39 (0.97–1.99)	0.06
Vaccine available in the United States for TB? (no vs. yes)	276 (55.5)	62 (52.5)	214 (56.5)	0.89 (0.64–1.21)	0.45
Know anyone with active TB?	101 (20.6)	27 (23.3)	74 (19.8)	1.17 (0.80–1.69)	0.42
Severity of TB diagnosis (serious/somewhat serious vs. not at all serious)	449 (90.2)	108 (91.5)	341 (89.7)	1.18 (0.66–2.09)	0.57
Would you tell friends/family about TB diagnosis? (yes vs. no)	399 (80.1)	97 (82.2)	302 (79.5)	1.15 (0.75–1.74)	0.52
Would you tell your sex partner about TB diagnosis? (yes vs. no)	474 (95.6)	109 (93.2)	365 (96.3)	0.63 (0.36–1.13)	0.17

TB = tuberculosis; QFT = QuantiFERON®-TB Gold In-Tube; + = positive; - = negative; CI = confidence interval.

Multivariable analysis of factors associated with *Mycobacterium tuberculosis* infection among persons who inject drugs, San Diego, CA, USA (*n* = 500)

Table 3

Variable	Adjusted prevalence ratio (95%CI)	P value
Race/ethnicity		<0.01
White	—	
Hispanic	1.82 (1.31–2.53)	
Black	1.36 (0.76–2.43)	
Other	1.39 (0.77–2.49)	
HIV-positive (reference: negative)	0.35 (0.14– 0.90)	0.02
HCV-positive (reference: negative)	1.87 (1.18–2.96)	0.01
Number of years injecting (per 5-year increase)	1.07 (1.01–1.13)	0.03

CI = confidence interval; HIV = human immunodeficiency virus; HCV = hepatitis C virus.