

# Influences of Cross-Border Mobility on Tuberculosis Diagnoses and Treatment Interruption Among Injection Drug Users in Tijuana, Mexico

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The epidemiology of tuberculosis (TB) is of special importance in border regions and areas with high concentrations of immigrants.<sup>1</sup> Foreign-born individuals account for more than half of the TB cases in the United States,<sup>2</sup> with the highest number occurring among individuals born in Mexico (24% of all cases among foreign-born individuals).<sup>3</sup> In California, the percentages of cases among foreign-born individuals (77%) and Mexican-born individuals (31% of cases among the foreign-born population) are even higher.<sup>4</sup> The potential for TB to spread across international borders recently entered the national consciousness when a traveler who had acquired multidrug-resistant TB provoked the first federal quarantine since 1963.<sup>5</sup> At present, the US Centers for Disease Control and Prevention recommend latent TB infection (LTBI) screening for immigrants from countries with high TB prevalence rates who have spent 5 or less years in the United States.<sup>6</sup>

The Mexican state of Baja California, adjacent to California, has the highest incidence of TB in Mexico: 57.3 cases per 100 000 individuals, or nearly triple the national average.<sup>7</sup> California has the highest total number of TB cases in the United States and the fourth highest incidence (7.6 per 100 000), following the District of Columbia, Alaska, and Hawaii.<sup>8</sup> San Diego, California, and Tijuana, the largest city in Baja California, share the world's busiest land border; 42 000 people cross daily from Tijuana to work in the United States,<sup>9</sup> and 46 million northbound trips are made each year.<sup>10</sup> With such an active and dynamic border area, it is not surprising that TB patients from both Tijuana and San Diego report contact with residents from the opposite side of the border.<sup>11</sup>

Research has shown that drug users, and injection drug users in particular, frequently travel back and forth across the US–Mexico border<sup>12</sup> and that these individuals are at high risk

**Objectives.** We sought to identify correlates of reported lifetime diagnoses of TB among injection drug users in the border city of Tijuana, Mexico.

**Methods.** Injection drug users in Tijuana were recruited into a prospective cohort study during 2006 and 2007. We used weighted multivariate logistic regression to identify correlates of TB diagnoses.

**Results.** Of the 1056 participants, 103 (9.8%) reported a history of TB, among whom 93% received anti-TB medication and 80% were diagnosed in the United States. Treatment was prematurely halted among 8% of patients; deportation from the United States was the cause of half of these treatment interruptions. History of travel to (odds ratio [OR]=6.44; 95% confidence interval [CI]=1.53, 27.20) or deportation from (OR=1.83; 95% CI=1.07, 3.12) the United States and incarceration (OR=2.20; 95% CI=1.06, 4.58) were independently associated with a reported lifetime diagnosis of TB.

**Conclusions.** Mobility and migration are important factors in identifying and treating TB patients diagnosed in the US–Mexico border region. Strengthening capacity on both sides of the border to identify, monitor, and treat TB is a priority. (*Am J Public Health.* 2009;99:1491–1495. doi:10.2105/AJPH.2008.142166)

of acquiring TB.<sup>6,13,14</sup> Levels of drug use in Tijuana, which is located on a major drug trafficking route, are 3 times higher than Mexico's national average.<sup>15</sup> A recent study conducted by our group showed that 70% of injection drug users in Tijuana had LTBI, and latent infection was significantly more prevalent among those who had been born in Mexico or who had lived in Tijuana their entire lives.<sup>16</sup> For our study, we investigated correlates of self-reported lifetime diagnoses of TB among injection drug users in Tijuana.

## METHODS

We analyzed cross-sectional baseline data from a prospective cohort study (described in detail elsewhere<sup>17</sup>) investigating the prevalence and incidence of and risk factors for HIV, syphilis, and TB infection among injection drug users in Tijuana. Eligible individuals were those who reported living in Tijuana, were 18 years or older, and had injected illicit drugs within the preceding month, as confirmed by inspection of injection

stigmata (“track marks”). Between April 2006 and April 2007, participants were recruited through respondent-driven sampling to achieve a more representative sample of this difficult-to-reach population.<sup>18</sup> Through this chain-referral sampling method, a diverse group of initial recruits (heterogeneous with respect to age, gender, drug of choice, and neighborhood) were selected and given uniquely coded coupons to refer their peers. Waves of recruitment continued as participants returning with coupons were each given 3 coupons to recruit others, and participants received \$5 for each person they recruited.

Study recruitment was facilitated through the use of a storefront office and a modified recreational vehicle that operated as a mobile clinic. Interviews were conducted by outreach workers employed by a local nongovernmental organization.

## Data Collection and Laboratory Testing

Trained staff used Spanish-language computer-assisted personal interviewing technology to administer quantitative surveys

collecting information on participants' socio-economic and demographic profiles, drug use, and sexual behaviors, among other participant characteristics. Surveys were developed in English, translated into Spanish, and then back-translated into English to verify accuracy and meaning. We asked participants about their city, state, and country of birth; length of residence in and reason for moving to Tijuana; history of travel to the United States; and number of border crossings within the preceding year. Additional TB risk factors assessed in our survey included history of tobacco and alcohol use, incarceration, and homelessness.

As a means of determining whether they had any symptoms potentially related to TB, participants were asked "Have you ever been told by a doctor or health care provider that you have TB (not including having a positive skin test without symptoms)?" Individuals answering in the affirmative were then asked to name the city, state, and country in which they had been diagnosed, along with the length of time (if any) they received medication. To account for potential confusion between active and latent TB, we asked participants whether it is possible to have TB that is "not an active form of disease" and whether they had received medication for LTBI or TB.

The Abbott Determine HIV-1/2 rapid test (Abbott Pharmaceuticals, Boston, MA) with Western blot confirmation was used to test participants for HIV antibodies; testing was conducted at the San Diego Public Health Laboratory. All participants were provided pretest and posttest counseling, and those testing positive for HIV or reporting symptoms consistent with TB were referred to a nearby public health clinic for a free evaluation.

### Data Analysis

Univariate logistic regression and nonparametric tests were used to separately compare injection drug users with and without a self-reported history of TB. We examined variables relating to participants' medical, substance use, and demographic histories, including migration history, to assess social and personal correlates of lifetime TB diagnoses. Associations with *P* values below .10 were included in multivariate logistic regression models with self-reported history of TB diagnosis as the dependent variable. Likelihood ratio tests were used to

compare nested models; variables significant at the .05 level were included in the final model. We also conducted deviance and Hosmer–Lemeshow goodness-of-fit tests.<sup>19</sup>

As a means of identifying possible bias from the respondent-driven sampling process, we used the Respondent-Driven Sampling Analysis Tool (Cornell University, Ithaca, NY) to generate overall sampling weights and applied these weights to our logistic regression model. The final regression model incorporated a set of weights based on network size, age, gender, and number of years of residence in Tijuana. Results from this model were compared with those from the unweighted model.

## RESULTS

Most (86%) of the 1056 eligible injection drug users who enrolled were men; participants' median age was 36 years (interquartile range [IQR]: 31–42 years; Table 1), and their median duration of injection drug use was 14 years (IQR: 9–20 years). More than two thirds (71%) had a history of incarceration in the United States or Mexico, and 18% were homeless. The crude (unweighted) HIV infection prevalence rate was 4%, and this rate did not differ significantly between individuals reporting and not reporting a lifetime history of TB (Table 1).

### Tuberculosis History and Treatment

Among the 1056 participants, 103 (9.8%) reported a history of being diagnosed with TB at some point in their lives, on average 10 years before they enrolled in the study (IQR: 6–16 years). Of these individuals, 84% understood that it is possible to have nonactive infection, and 80% reported having been diagnosed with TB in the United States.

Of the 103 participants reporting a TB history, 96 (93%) reported receiving anti-TB medication, among whom 92% reported completing at least 6 months of medication; 8 participants (7.8%) reported that they stopped taking their medication before they were advised to do so. Among the 8 individuals who reported stopping treatment prematurely, 4 (who were not diagnosed in San Diego) cited deportation as the primary reason; other reasons included medication-related side effects (*n*=1) and a perception that the medication was no longer needed (*n*=2). One individual did not specify a reason.

Among all 1056 participants, an additional 77 (7.3%) reported receiving medication for LTBI; further treatment data were not available for this group.

### Mobility and Migration

Seventy-six percent of all participants in our survey had moved to Tijuana from another city, and within this subgroup, those reporting a history of TB had lived in Tijuana for significantly (*P*<.01) shorter periods of time than had those not reporting a history of TB (median durations of 5 and 8 years, respectively; Table 1). Among injection drug users who had moved to Tijuana, those with a history of TB were more likely than those without such a history to report having moved because they had been deported from the United States (74% vs 49%; *P*<.01).

In comparison with those who had never been diagnosed with TB, those reporting a history of TB were significantly more likely to have traveled to the United States at some point in their lives (94% vs 76%; *P*<.01). Most injection drug users (86%) who reported having been diagnosed with TB in the United States indicated that they had been diagnosed in California, although only 15% named San Diego as their city of diagnosis. Individuals traveling to the United States were also significantly more likely to report having undergone tuberculin skin testing (26% vs 12%; *P*<.05). Only 4% of injection drug users with a history of TB and 7% overall had crossed the Mexico–US border in the preceding year.

### Factors Independently Associated With Tuberculosis Diagnoses

A multivariate model (Table 2) was separately constructed with nonweighted and weighted variables, the latter accounting for respondent-driven sampling. In both models, factors independently associated with a self-reported lifetime diagnosis of TB included history of travel to the United States (odds ratio [OR]=6.44; 95% confidence interval [CI]=1.53, 27.2), having moved to Tijuana because of deportation (OR=1.83; 95% CI=1.07, 3.12), and history of incarceration (OR=2.20; 95% CI=1.06, 4.58). Median number of years of education and median number of years of injection drug use were significant in the nonweighted but not the

**TABLE 1—Demographic, Migration, and Health-Related Characteristics Associated With Self-Reported History of TB Among Injection Drug Users: Tijuana, Mexico, 2006–2007**

	Overall, % or Mean (IQR)	History of TB Diagnosis	
		Yes, % or Mean (IQR)	No, % or Mean (IQR)
<b>Demographic characteristics</b>			
Men	88	93*	86
Age, y	36 (31–42)	40 (35–46)**	36 (30–41)
Years of education	7 (6–9)	9 (6–11)**	7 (6–9)
Monthly income < 3000 pesos (\$275)	31	27	31
Years of injection drug use	14 (8–21)	18 (12–25)**	14 (8–21)
Homeless	18	17	19
History of incarceration	71	87**	70
<b>Migration history</b>			
Born in Mexico	98	99	98
Born in Baja California	33	35	33
Ever traveled to United States	78	94**	76
Crossed border into United States in past y	7	4	7
Has not lived entire life in Tijuana	76	82	76
Moved to Tijuana because of deportation <sup>a</sup>	51	74**	49
Years living in Tijuana <sup>a</sup>	8 (3–19)	5 (1–15)*	10 (4–19)
Diagnosed with TB in US	7	80	...
<b>Health behavior and history</b>			
Tobacco use	92	92	92
Weekly alcohol use	23	21	23
Knows other individuals who have had TB	42	53*	41
Understands that TB may be inactive	78	84	77
HIV positive <sup>b</sup>	4	1	4

Note. TB = tuberculosis; IQR = interquartile range. For the overall sample, N = 1056; for those with a history of TB, n = 103; for those with no history of TB, n = 953.

<sup>a</sup>Not including injection drug users born in Tijuana (overall, n = 809; those with a history of TB, n = 85; those with no history of TB, n = 724).

<sup>b</sup>Not weighted for respondent-driven sampling.

\*P < .05; \*\*P < .01 (for difference between groups with and without a history of TB).

weighted model. Because parameter estimates did not change appreciably between models, we present the nonweighted estimates in Table 2 (in line with recommendations from previous research<sup>20</sup>).

## DISCUSSION

Our study produced several novel findings related to reported lifetime diagnoses of TB among injection drug users in a large Mexico–US border city. Compared with injection drug users not reporting a history of TB, those reporting such a history were 6 times more likely to have traveled to the United States. In

addition, injection drug users with a lifetime diagnosis of TB were nearly twice as likely as other Tijuana migrants to be living in the city as a result of having been deported from the United States. The confidence interval for the odds ratio corresponding to history of travel to the United States was wide, primarily because of the small percentage (6%) of individuals reporting TB who had not traveled to the United States. Nonetheless, the relationship was strong and was consistent with previous reports indicating a high degree of mobility among individuals diagnosed with TB<sup>11</sup> and transmission of mycobacterial strains between Mexico and the United States.<sup>21</sup>

## Tuberculosis Diagnoses

A number of studies focusing on TB cases in US border regions have documented the influence of migration on the epidemiology of TB.<sup>1,22,23</sup> Our study is unique in that we surveyed injection drug users in Mexico and found that 80% who reported having received a TB diagnosis had been diagnosed in the United States. Several factors could explain this finding. For example, binational use of health care services is common in the US–Mexico border region,<sup>24</sup> and the more frequent diagnoses in the United States may have reflected a higher clinical suspicion of TB among migrants to the United States.

Differences in TB screening may offer another potential explanation; official Mexican guidelines recommend LTBI screening only for contacts of a TB patient when the contact is HIV positive, or is a child younger than 5 years, or if he or she has no history or evidence of bacille Calmette–Guérin vaccination if between the ages of 5 and 14 years.<sup>25</sup> The general absence of LTBI screening in Mexico may imply that injection drug users who did not travel to the United States, where the Centers for Disease Control and Prevention recommend targeted LTBI screening for both injection drug users and individuals from countries with high TB incidence rates,<sup>6</sup> had fewer opportunities to receive TB-related services.

Although immigrants applying for visas to the United States undergo overseas screening for TB, such programs do not reach undocumented immigrants and nonimmigrant visitors, both of whom are important sources of TB morbidity in border communities.<sup>23</sup> Most cases of TB among foreign-born individuals are diagnosed in venues other than formal screening programs,<sup>26</sup> and it is likely that many of the diagnoses reported by injection drug users in our study occurred in such venues. Nonetheless, our finding that injection drug users traveling to the United States were more likely to report being diagnosed with TB in their lifetime remains somewhat surprising, given the reduced access to care frequently experienced by US immigrants.<sup>12,27,28</sup>

## Treatment Interruption

Several of our participants stated that they had been deported before they could complete TB treatment, illustrating the challenge of TB control among mobile populations. Nationally, approximately 150 TB cases are identified

**TABLE 2—Results of Univariate and Multivariate Analyses of Factors Associated With a History of TB Diagnosis Among Injection Drug Users (N = 1056): Tijuana, Mexico, 2006–2007**

	Univariate OR (95% CI)	Unweighted Multivariate OR <sup>a</sup> (95% CI)
Men	2.29 (1.04, 5.02)	...
Age (odds per year)	1.05 (1.02, 1.07)	...
Years injecting (odds per year)	1.04 (1.02, 1.06)	...
Years of education (odds per year)	1.10 (1.04, 1.18)	...
Lifetime history of travel to the United States	5.11 (2.21, 11.80)	6.44 (1.53, 27.20)
Years living in Tijuana <sup>b</sup> (odds per year)	0.98 (0.96, 1.00)	...
Moved to Tijuana because of deportation from US <sup>b</sup>	3.03 (1.82, 5.03)	1.83 (1.07, 3.12)
Lifetime history of incarceration	3.01 (1.66, 5.48)	2.20 (1.06, 4.58)
Knows other individuals who have had TB	1.67 (1.11, 2.51)	...

Note. TB = tuberculosis; OR = odds ratio; CI = confidence interval.

<sup>a</sup>Only variables which were selected in both nonweighted and weighted models are shown.

<sup>b</sup>Not including injection drug users born in Tijuana (n = 809).

each year among immigrant detainees in US Immigration and Customs Enforcement (ICE) processing centers and contract detention facilities; although ICE policies do not require treatment completion, detainees are treated until they are no longer contagious.<sup>29</sup> A system of binational monitoring has been established to allow individuals who cross the border to receive uninterrupted TB treatment,<sup>30</sup> and ICE detainees are routinely enrolled in this program.<sup>31</sup>

Our results are consistent with early assessments of outcomes among TB patients in ICE custody. We found that 80% of all TB patients were enrolled in an international TB referral program, with 58% completing treatment and 23% either lost to follow-up or with no reported outcome.<sup>32</sup> Elsewhere, deportation has been shown to be associated with an increased risk of HIV infection among Tijuana injection drug users. In light of challenges such as detainee mobility and the decentralized nature of ICE detention, coordination of care between different TB referral programs warrants continued attention.<sup>33</sup>

### Additional Risk

History of incarceration is a well-established risk factor for TB<sup>34,35</sup> and was also associated with a lifetime diagnosis of TB disease in our study. This finding may reflect increased prison transmission or an increased level of case-finding in US prisons. At present, national screening recommendations vary according to the TB risk in a given correctional facility's population;

however, these recommendations typically include symptom assessments and tuberculin skin testing or chest radiographs in higher risk settings.<sup>36</sup> Provision of LTBI treatment in US prisons is inconsistent.<sup>37</sup> A longer history of injection drug use, which we found to be associated with a greater likelihood of TB in our univariate analysis, is also a well-known risk factor for TB.<sup>38,39</sup>

### Limitations

Several limitations should be considered when interpreting the results of this study. For example, we used cross-sectional data, so causal inferences regarding associations between migration history and TB diagnosis or treatment cannot be drawn. In addition, we were unable to determine the point at which individuals were infected with TB or whether they may have traveled to the United States to seek treatment.

Finally, we relied on self-reported history of TB, and medical records were not available that would have allowed us to confirm whether injection drug users were diagnosed with and treated for LTBI or TB. It is possible that clinical diagnoses were inaccurate or that individuals confused a diagnosis of LTBI and TB, a common issue in TB studies involving injection drug users.<sup>40,41</sup> The small number of individuals reporting a TB diagnosis who did not receive medication suggests that either of these possibilities may have occurred, although to a limited degree; our interviewer-administered survey, designed to distinguish between these conditions

through detailed probes, probably minimized this confusion. Overall, our finding that injection drug users reported a much higher likelihood of being diagnosed with and treated for TB in the United States than Mexico is important and reflects a level of screening and treatment appropriate for this high-risk group.

### Recommendations

Our study has important implications for the diagnosis and treatment of TB in the US–Mexico border region, where mobility and migration are common. Investment in TB-control efforts in Mexico has been shown to be a cost-effective strategy in the United States in that it has reduced the number of TB cases among US migrants.<sup>42</sup> The likelihood of migration is an important consideration in the management of individuals identified with TB, and the importance of treatment completion cannot be understated, in terms of both providing adequate care and preventing the development of drug-resistant strains. Given that failure to take into account the mobility of individuals with TB can undermine TB-control efforts in both Mexico and the United States, strengthening capacity on both sides of the border to identify and monitor patients with TB should remain a priority. ■

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### Contributors

R. Deiss was the principal writer and prepared the analysis for the article. R.S. Garfein assisted in the writing and analysis and helped originate the study and develop the survey instrument. R. Lozada oversaw implementation of the study in Tijuana. J.L. Burgos and V.D. Ojeda assisted in the writing of the article. K.C. Brouwer assisted in the writing of the article and the development of the survey instrument. K.S. Moser provided input on the study design and assisted with article revisions. M.L. Zuniga assisted in the writing of the article and interpretation of the results. T.C. Rodwell

assisted in the development of the survey instrument and contributed to revisions of the article. S.A. Strathdee designed the study, supervised all study components including preparation of the article, and contributed to article revisions.

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### Human Participant Protection

This study was approved by the institutional review board of the University of California, San Diego, and the ethics board of the Tijuana General Hospital. All participants provided written informed consent.

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