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Self-Reported Engagement in Care among U.S. Residents with Latent Tuberculosis Infection – 2011-2012

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Abstract

Background: The objective of the study was to provide estimates of and risk factors for engagement in LTBI care in the overall U.S. population and among specific risk groups.

Methods: We used nationally representative data from 7,080 participants in the 2011-2012 National Health and Nutrition Examination Survey. Engagement in LTBI care was assessed by estimating the proportion with a history of testing, diagnosis, treatment initiation and treatment completion. Weighted methods were used to account for the complex survey design and to derive national estimates.

Results: Only 1.4 million (10%) of an estimated 14.0 million individuals with LTBI had previously completed treatment. Of the 12.6 million who did not complete LTBI treatment, 3.7 million (29%) had never been tested and 7.2 million (57%) received testing but had no history of diagnosis. High-risk groups showed low levels of engagement, including TB contacts and persons born outside the United States.

Conclusions and relevance: There is a reservoir of more than 12 million individuals in the U.S. who may be at risk for progression to TB disease and potential transmission. TB control programs and community providers should consider focused efforts to increase testing, diagnosis, and treatment for LTBI.

Keywords

Latent Tuberculosis Infection; TB Epidemiology; NHANES; Engagement in care

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Depending on which test is used, an estimated 12 to 14 million U.S. household residents aged 6 years and older were infected with latent tuberculosis infection (LTBI) during 2011-2012 (1, 2). The Centers for Disease Control and Prevention (CDC) has highlighted the importance of targeted testing and treatment of LTBI as a necessary component for TB elimination in the United States (3). Recently, the U.S. Preventive Services Task Force (USPSTF) gave screening for LTBI in populations at increased risk a "B" recommendation, meaning that that they recommend testing (4).

However, the effectiveness of interventions aimed at testing and treatment of LTBI is dependent upon clinical provider action and patient engagement in care. The elements of patient engagement in care, referred to as the “cascade of care,” originally started with HIV infection but have progressed to TB and other infections (5). Selected elements of engagement in LTBI care have also been measured previously but have largely focused on steps later in the cascade. For example, treatment initiation has been estimated at 26-91% (6-8) and completion at 29-62% (7-13), although these estimates vary considerably depending on the study setting, population, and methodology (14). However, these studies have neglected early aspects of LTBI engagement, such as likelihood of testing and diagnosis among those infected. Recent studies have begun to include earlier steps in the cascade but many have been restricted to specific populations (15). A 2016 systematic review compiled a full cascade of care based on 58 studies, estimating that on average, 65% of LTBI patients were lost to follow-up in the initial stages of care of testing and diagnosis (5).

Nationally representative estimates of LTBI patient care engagement are important in assessing the prevalence of and risk factors for untreated LTBI in the general U.S. population and in high-risk groups that are specifically targeted for testing, including non-US-born persons and close contacts of cases of TB disease (4). The primary objective of the current study was to provide estimates of and factors associated with engagement in LTBI care in the U.S. population overall, as well as among selected high-risk groups.

METHODS

Survey methodology:

This report is based on publicly available data from the 2011-2012 National Health and Nutrition Examination Survey (NHANES) (16). The NHANES is a large, representative, population-based survey developed and led by CDC that provides estimates of disease prevalence in the non-institutionalized civilian resident United States population. The NHANES protocol #2011-17 was reviewed by the National Centers for Health Statistics' Ethics Review Board. TB infection testing included both the tuberculin skin test (TST) and an interferon-gamma release assay (IGRA), the Quantiferon® Gold-in-tube (QFT) (Qiagen, Germantown, MD). TB-specific questions used to measure engagement in care and the self-reported definitions of engagement are shown in Table 1 (16). As the participants were unaware of their QFT results at the time of the survey, the responses reflected participants’ engagement in TB care prior to the survey, not afterwards.

Statistical Analysis:

We adapted the analysis plan from the methods used in a previous analysis of NHANES TB data (1). Data analyses were performed using R version 3.4.2 and the *survey* package version 3.32-1 (17, 18). Only survey respondents with valid, non-indeterminate QFT results were eligible for inclusion in this analysis. We excluded respondents with a self-reported history of TB disease because their answers to the questions that determined engagement in the LTBI treatment cascade could not be accurately interpreted. All analyses accounted for the complex survey design by using NHANES 2011-2012 Medical Examination Center 2-year weights to adjust for sample survey design, with reweighting for nonparticipation in TB testing described in detail in previous analyses (1, 2).

Univariate associations between engagement and demographic variables were quantified by unadjusted odds ratios and 95% confidence intervals incorporating the complex survey design. Weighted multivariate logistic regression was used to examine the independent effects of factors associated with engagement adjusted for the other variables in the models. When performing regression to look for risk factors for engagement, the population (domain) for each analysis was conditional on achieving the previous step in the cascade.

RESULTS

The 2011-2012 NHANES included 9,756 subjects, of whom 8,161 were ages 6 years and older and thus eligible for the TB testing component of the study. Of those, 7,080 (87%) had a valid, non-indeterminate QFT result. Of these, 38 had a history of TB disease and 34 had a missing history, leaving 7,008 individuals eligible for inclusion. Of these, there were 522 who had a positive QFT, corresponding to a weighted U.S. population of 14,012,000. This was the primary population used in analyses of LTBI engagement in care. The weighted and unweighted populations at each step in the cascade of care are shown in Figure 1.

The cascade of engagement in LTBI care in the United States, demonstrated in Figure 1, shows that among those with a positive QFT, only 50.0% of those who had been diagnosed were prescribed treatment, and most (88.4%) of those who reported LTBI treatment said they completed it. However, 10.9 million of the 14.0 million of those infected with LTBI (77.9%) fell into the earlier part of the cascade, i.e. had never been tested or diagnosed. An estimated 12.6 million (90.2%) of those infected with LTBI in the United States have not completed treatment and may be at risk for progression to TB disease, of whom 10.9 million (86%) reported no prior testing or LTBI diagnosis; 3.7 million had never been tested and 7.2 million had no history of diagnosis.

Estimates of engagement according to selected demographic characteristics and TB exposures are shown in Table 2. Point estimates for engagement were consistently higher among participants who were women, non-Hispanic Blacks, and contacts of a case of TB disease, although these were only significant in the earlier stages of the cascade. Two high-risk groups recommended for testing, contacts and non-US-born participants, had low engagement within all steps of the cascade (Figure 3 and Table 2), although again these differences were only significant at earlier stages in the cascade.

Table 3 examines factors associated with the first two steps of the cascade of LTBI care, testing and diagnosis, among persons with a positive QFT. Female sex and TB contacts were associated with increased history of testing None of the measured variables was associated with prior diagnosis of LTBI. Engagement among those with LTBI as measured by positive TST (supplemental table 1) were generally similar to those measured by the QFT, although the associations were divided across the different steps (testing and diagnosis) of the cascade. We were unable to assess factors associated with treatment initiation and completion because the small absolute numbers of study participants led to unreliable estimates.

Table 4 shows estimates of prior testing and diagnosis among selected high-risk populations using the entire population, not just the population indicated by QFT to be currently infected at the time of the NHANES examination. An estimated 86.1% of TB contacts reported having ever been tested for LTBI; this varied significantly by current LTBI status. In contrast, only 63.1% of non-US-born persons had previously been tested for LTBI; this did not vary by LTBI status. Diagnosis among these high-risk groups was similar, with 11.4% of contacts and 9.4% of non-US-born reporting a prior diagnosis of LTBI; diagnosis varied in both populations by current LTBI status.

DISCUSSION

This report is the first to provide nationally representative estimates of the full cascade of patient engagement in LTBI care in the United States. Levels of engagement were seen to drop off precipitously during each step in the cascade, resulting in 1.4 million (10%) of the 14.0 million individuals with LTBI previously completing treatment; this was similar to a previous estimate (19). This analysis shows that assessing the effectiveness of an LTBI screening program based on the traditional measurement of treatment initiation and completion fails to reveal the fact that most persons are lost from the cascade of LTBI care prior to entering these late steps in the cascade of care. That is, of the estimated 12.6 million with a positive QFT (indicating LTBI) but who had not completed treatment, an estimated 3.7 million (29%) were never tested and 7.2 million (57%) were tested but were not diagnosed. The factors associated with engagement varied according to the step in the cascade of care and by the test used for LTBI. Persons identified as high risk for TB by the CDC (20, 21) and recommended for testing by the USPSTF (4) also showed suboptimal levels of engagement, with only 20.7% of TB-infected non-US-born persons and 41.8% of TB-infected TB contacts reporting a known diagnosis of LTBI.

Until recently (5, 15), previous studies examining LTBI treatment have focused on treatment initiation and completion, whereas this report focuses on factors associated with self-reported prior testing and diagnosis. Previous studies found that TB contacts had higher levels of treatment initiation and completion (7), as did this study. In a meta-analysis of studies of LTBI treatment completion, the authors found no consistent associations with most patient demographic characteristics such as sex, age, and birth outside the United States (14). In contrast, they found that recent exposure to TB, higher education, and certain attitudes and beliefs were associated with higher levels of completion. In addition to shorter treatment regimens such as 4 months of daily rifampin (22) or 3 months of weekly isoniazid

and rifapentine (23), other interventions such as directly observed therapy, patient education, and patient incentives have been shown to increase treatment completion (14). Our study found higher levels of testing among women and those with more education and lower levels among non-US-born persons, although these factors varied slightly by the test used to assess presence of LTBI. A recent meta-analysis found more limited data on the earlier steps in the cascade of care, but had similar findings as our study, in that the majority of losses to care occurred at the earlier steps in the cascade; i.e. only 72% having been tested and 35% recommended for treatment (5).

Although TB contacts had higher levels of LTBI treatment completion (27.0%) than non-contacts (8.5%), levels were well below targets proposed by CDC and in Healthy People 2020 (24). The CDC Division of Tuberculosis Elimination (DTBE), in consultation with state TB programs, set a 2025 goal of having 94% of contacts of cases with positive acid-fast bacillus sputum smears tested, and reported that 82% had actually been tested during 2003-2012 (13, 25); our study similarly found that 86% had been tested. CDC 2025 targets are 92% treatment initiation among those contacts who are diagnosed with LTBI and 93% completion among those who initiate (25). However, completion indicators do not lend themselves to understanding the true size of the infected population because they ignore the large drop-off in engagement from lack of testing and diagnosis. Program indicators focusing only on testing initiation and treatment only look “where the light is good,” which limits the effectiveness of TB interventions. This further suggests the need to widen our gaze within TB control to improve engagement in the first stage of the cascade; i.e. “where the light is bad.” For example, while 95.5% of contacts with LTBI at the time of the survey reported having been previously tested, only 41.8% had ever been diagnosed with LTBI (table 2).

Non-US-born populations in the U.S. have been found to have low proportions of recruitment in testing programs (51%), diagnosis (39%), treatment being offered (50%), and treatment completion (69%) (26). Non-US-born populations are particularly important because they account for between 53 and 73% of all LTBI infections (1, 2) and 70% of all cases of TB disease (27) in the United States, but have been less likely to receive LTBI testing and diagnosis, suggesting the need to improve engagement in testing and diagnosis in these populations.

The strengths of this study include its large sample size, generalizability to the U.S. population, and in its ability to assess engagement in care prior to treatment initiation. This last point is probably the most important since previous studies were not able to assess engagement prior to individual showing up for LTBI care in a health care setting. The most important limitation is the potential misclassification of levels of previous engagement in care since these were self-reported. While no “gold standard” for measuring adherence exists, self-reported measures may suffer from recall bias, social desirability bias, and overestimation (14). It is also important to note that although participants may have been infected during the time between their prior engagement in care and the survey, and they may have been treated after the survey. Although results were provided to participants 12-16 weeks after the survey, and they were encouraged to discuss these results with their personal health care providers, no data on follow-up care were collected. On the other

hand, our study may underestimate levels of prior diagnosis since some individuals may not accept or understand this diagnosis. Health care providers are another source of variability in communicating the diagnosis and the importance of treatment of LTBI to their patients (28), but provider factors could not be assessed in this study. Similarly, there is no gold standard for LTBI diagnosis, so there was likely some misclassification in current LTBI status. Alternatively, some persons could have been uninfected and therefore undiagnosed at the time of prior testing, with infection occurring subsequently, accounting for their lack of prior engagement. The number of participants in certain important high-risk groups such as those with HIV was not sufficient to assess engagement or associated risk factors. Additionally, NHANES did not capture information on certain well-established risk factors for LTBI that could have been used to target testing, such as immunocompromising medical conditions other than HIV, high-risk occupations, and experiencing homelessness or living in other congregate settings (29). The lack of inclusion of individuals who were incarcerated, homeless, or living in other congregate settings may have decreased our overall estimates (30). Finally, these estimates apply to the United States only and cannot be generalized to other countries.

Epidemiological data, in combination with supporting modelling data (31), suggest that treatment of LTBI can have the greatest potential for impact on TB elimination. In our study, 12.6 million (90%) of the estimated 14 million persons infected with LTBI were untreated and thus risked progressing to TB disease and potentially transmitting infection to others. Although some heterogeneity exists between studies and within populations, engagement clearly needs to be improved in all steps of the cascade in all populations. Nevertheless, LTBI testing has a much greater impact on TB control when it is targeted to populations with high prevalence of LTBI (20). This study further highlights the lack of testing which exists among these high-risk groups in the United States. TB control programs and community clinical care providers should focus their efforts in groups with high concentrations of untreated LTBI such as contacts of TB cases, the homeless, and in particular non-US-born persons (4, 20). LTBI testing and treatment of persons who are not household or other close contacts of patients with TB disease is the “new frontier” of TB elimination, but it will require a major, coordinated effort to address and scale-up treatment to levels which will have the greatest impact on the incidence of tuberculosis disease (32).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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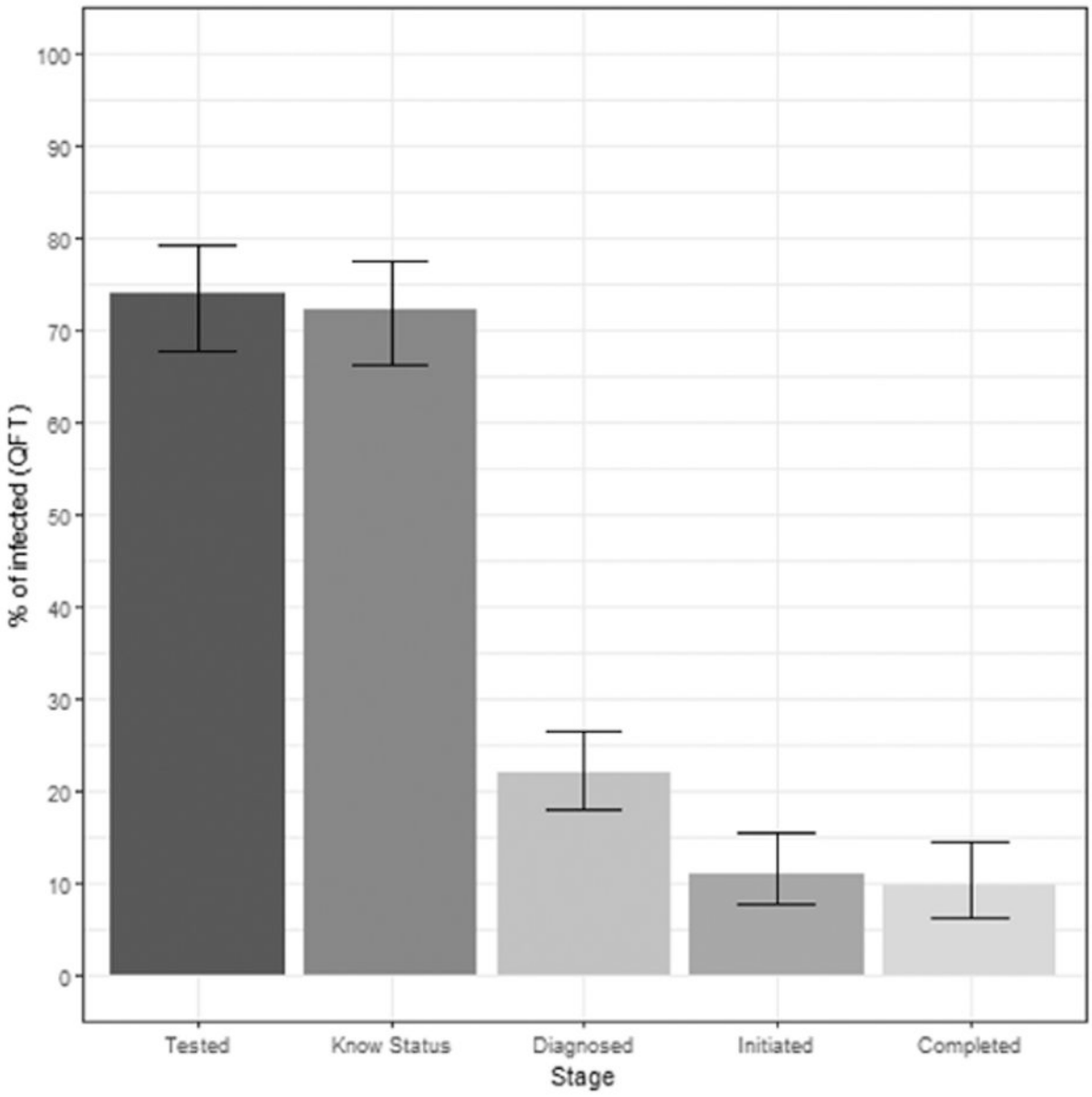

Figure 1.

Cascade of self-reported engagement in the care of latent tuberculosis infection in the United States, 2011-2012 among persons 6 years and older with a positive QFT result

Source: National Health and Nutrition Examination Survey

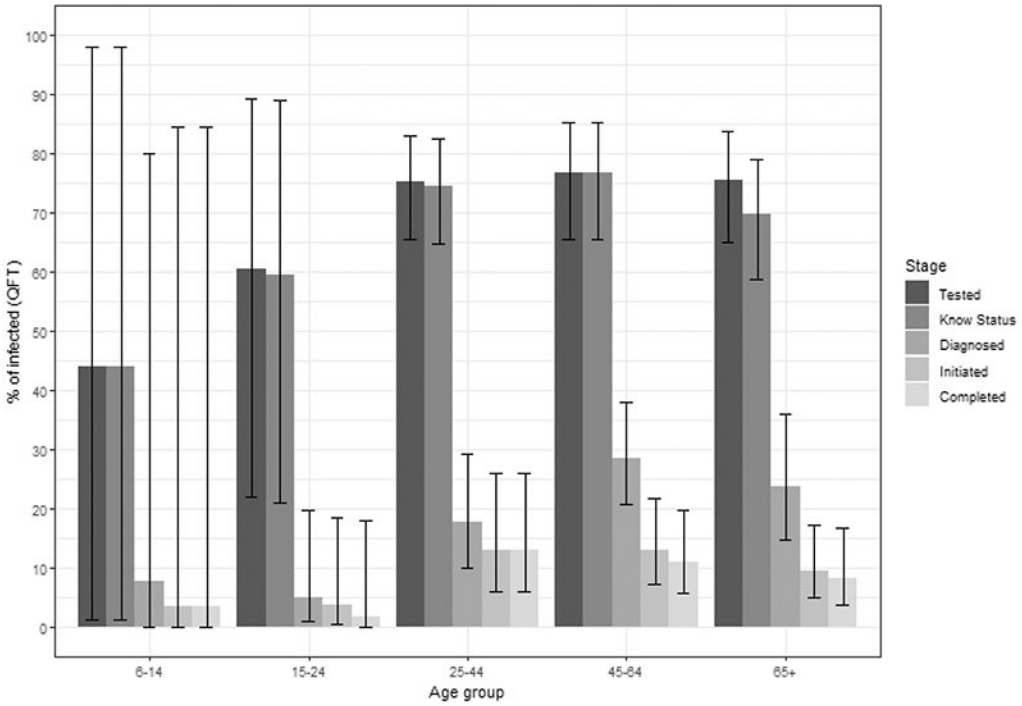

Figure 2.

Cascade of self-reported engagement in the care of latent tuberculosis infection in the United States, 2011-2012 among persons 6 years and older with a positive QFT result, by age group

Source: National Health and Nutrition Examination Survey

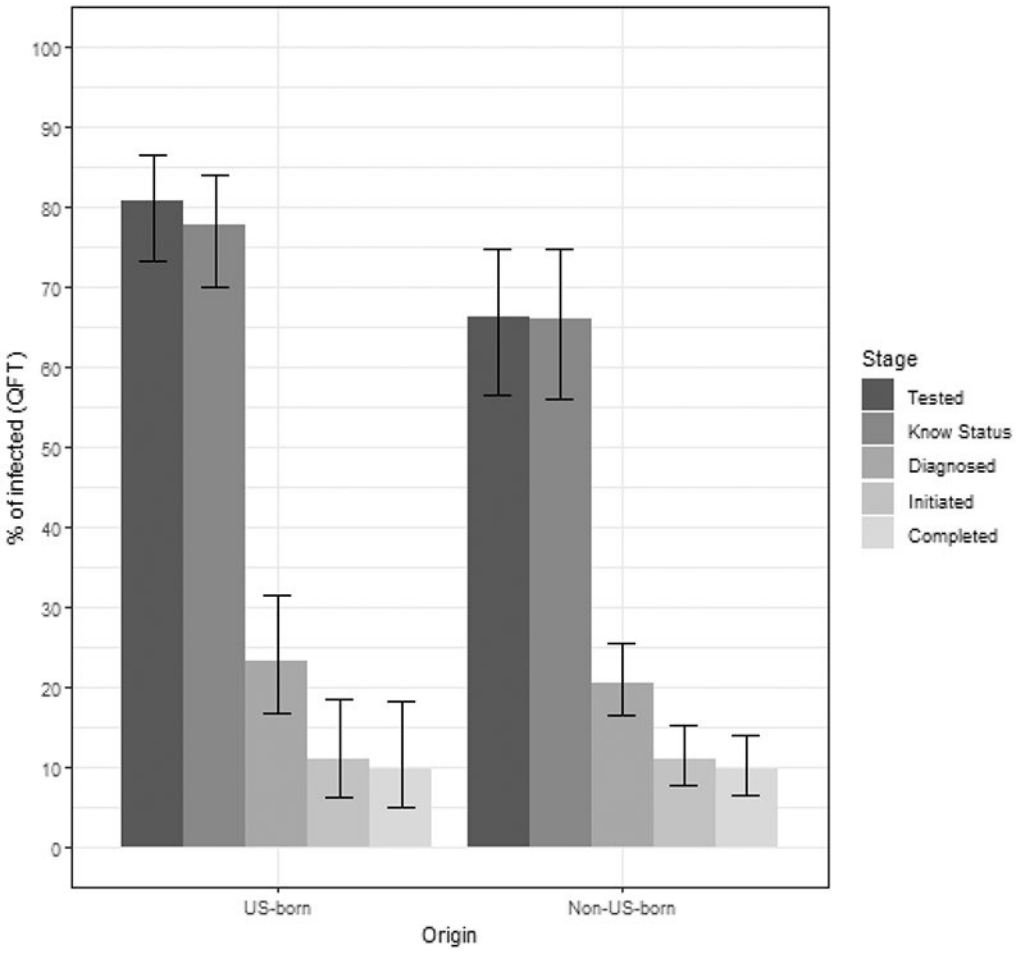

Figure 3.

Cascade of self-reported engagement in the care of latent tuberculosis infection in the United States, 2011-2012 among persons 6 years and older with a positive QFT result, by nativity

Source: National Health and Nutrition Examination Survey

Table 1.

Case Definitions of Engagement based on Survey Questions

Engagement Term	Survey Question
Tested	Have you ever been tested for TB? (Answered “yes” to this question)
Know Status	Were you told that your (skin/blood/tine) * test was positive for TB? (Answered “yes” or “no” to any one of these 3 questions)
Diagnosed	Were you told that your (skin/blood/tine) * test was positive for TB? (Answered “yes” to any one of these 3 questions)
Initiated	After getting a positive TB test, were you prescribed any medicine to keep you from getting sick with TB?
Completed	Did you complete this treatment?

* Note: three questions were asked, one for each test type: skin, blood, and tine.

Table 2.

Cascade of self-reported engagement in the care of latent tuberculosis infection in the United States by selected characteristics, 2011-2012

Characteristic	QFT Positive	Tested		Know status		Diagnosed		Initiated		Completed	
	Pop. x1,000 (95% CI)	Pop. x1,000 (95% CI)	% (95% CI)	Pop. x1,000 (95% CI)	% (95% CI)	Pop. x1,000 (95% CI)	% (95% CI)	Pop. x1,000 (95% CI)	% (95% CI)	Pop. x1,000 (95% CI)	% (95% CI)
Overall	14,014 (11,921-16,452)	10,362 (8,512-12,595)	73.9 (67.8-79.3)	10,131 (8,302-12,345)	72.3 (66.3, 77.6)	3,095 (2,351-4,070)	22.1 (18.1, 26.6)	1,550 (1,062-2,259)	11.1 (7.8, 15.5)	1,370 (889-2,111)	9.8 (6.4, 14.6)
Sex											
Male	7,866 (6,625-9,322)	5,273 (4,104-6,759)	67.0 (58.1-74.9)	5,121 (3,996-6,547)	65.1 (56.4, 72.9)	1,504 (939-2,403)	19.1 (13.1, 27.0)	537 (298-966)	6.8 (4.1, 11.1)	443[#] (230-855)	5.6 (3.1, 10.1)
Female	6,152 (4,930-7,662)	5,094 (4,039-6,412)	82.8 (75.0-88.5)	5,015 (3,941-6,368)	81.5 (73.3, 87.6)	1,591 (1,079-2,341)	25.9 (17.5, 36.4)	1,006 (652-1,551)	16.4 (10.2, 25.3)	920 (564-1,500)	15.0 (8.8, 24.2)
Age (years)											
6-14	262[#] (123-557)	116[*#] (51-261)	44.1[*#] (1.2-98.0)	116 (51-261)	44.1[*#] (1.2, 98.0)	20[*#] (4-94)	7.8[*#] (0.2, 80.0)	10[*#] (1-83)	3.7[*#] (0.0, 84.4)	10[*#] (1-83)	3.7[*#] (0.0, 84.4)
15-24	1,239 (849-1,800)	749 (420-1,326)	60.5 (22.1-89.2)	736 (410-1,312)	59.4 (21.1, 88.9)	62[*#] (18-210)	5.0[*#] (1.1, 19.7)	47[*#] (11-207)	3.8[*#] (0.7, 18.7)	23[*#] (3-192)	1.9[*#] (0.2, 18.0)
25-44	3,403 (2,700-4,278)	2,562 (1,911-3,424)	75.3 (65.4-83.1)	2,539 (1,887-3,407)	74.6 (64.7, 82.5)	603[#] (314-1,152)	17.7 (10.0, 29.4)	442[#] (193-1,008)	13.0[#] (6.0, 26.0)	442[#] (193-1,008)	13.0[#] (6.0, 26.0)
45-64	5,618 (4,078-7,682)	4,315 (2,964-6,234)	76.8 (65.6-85.2)	4,315 (2,964-6,234)	76.8 (65.6, 85.2)	1,607 (972-2,645)	28.6 (20.7, 38.0)	731 (415-1,285)	13.0 (7.4, 21.8)	619 (339-1,127)	11.0 (5.8, 19.9)
65+	3,495 (2,765-4,396)	2,639 (1,979-3,499)	75.5[#] (65.0-83.6)	2,438 (1,818-3,253)	69.8 (58.7, 78.9)	835 (481-1,437)	23.9[#] (14.9, 36.0)	332[#] (159-691)	9.5[#] (5.0, 17.4)	288[#] (123-669)	8.2[#] (3.8, 16.8)
Race/ethnicity											
Non-Hispanic white	5,140 (3,719-7,081)	4,068 (2,708-6,088)	79.2 (67.8-87.2)	3,915 (2,588-5,900)	76.2 (65.2, 84.5)	1,064 (599-1,886)	20.7 (12.8, 31.7)	398[*#] (136-1,157)	7.7[*#] (2.5, 21.5)	356[*#] (108-1,165)	6.9[*#] (2.0, 21.5)
Non-Hispanic black	2,009 (1,554-2,587)	1,748 (1,286-2,365)	87.0 (77.0-93.1)	1,672 (1,208-2,302)	83.2 (72.7, 90.2)	754 (503-1,127)	37.5 (28.1, 48.0)	417 (265-654)	20.7 (13.0, 31.4)	345 (196-605)	17.2 (9.6, 28.7)
Hispanic	4,343 (3,636-5,169)	2,882 (2,373-3,490)	66.4 (58.2-73.7)	2,882 (2,373-3,490)	66.4 (58.2, 73.7)	730 (510-1,044)	16.8 (13.1, 21.4)	508 (345-747)	11.7 (8.6, 15.7)	467 (298-730)	10.8 (7.3, 15.5)
Non-Hispanic Asian	2,239 (1,879-2,654)	1,402 (1,074-1,817)	62.6 (46.1-76.7)	1,402 (1,074-1,817)	62.6 (46.1, 76.7)	505 (348-729)	22.6 (14.7, 32.9)	210 (138-319)	9.4 (5.7, 15.0)	188 (123-288)	8.4 (5.2, 13.3)
Other	198[*#] (48-757)	166[*#] (46-570)	83.6[*] (NA)	166 (46-570)	83.6[*] (NA)	11[*#] (1-91)	5.7[*#] (NA)	0[*] (NA)	0[*] (NA)	0[*] (NA)	0[*] (NA)
Nativity											
U.S.	7,263 (5,328-9,871)	5,866 (4,100-8,367)	80.8 (73.2-86.6)	5,646 (3,898-8,152)	77.7 (69.9, 84.0)	1,695 (1,109-2,588)	23.3 (16.8, 31.5)	799 (437-1,458)	11.0 (6.2, 18.6)	709[#] (357-1,405)	9.8[#] (5.0, 18.2)

Characteristic	QFT Positive	Tested		Know status		Diagnosed		Initiated		Completed	
	Pop. x1,000 (95% CI)	**Pop. x1,000 (95% CI)**	**% (95% CI)**	**Pop. x1,000 (95% CI)**	**% (95% CI)**	**Pop. x1,000 (95% CI)**	**% (95% CI)**	**Pop. x1,000 (95% CI)**	**% (95% CI)**	**Pop. x1,000 (95% CI)**	**% (95% CI)**
Non-U.S.	6,084 (5,183-7,109)	4,038 (3,453-4,709)	66.4 (56.6-74.9)	4,024 (3,444-4,688)	66.1 (56.1, 74.9)	1,257 (980-1,608)	20.7 (16.5, 25.5)	672 (444-1,014)	11.1 (7.8, 15.4)	592 (382-915)	9.7 (6.6, 14.1)
Income											
Non-poverty	8.861 (7,210-10,869)	6,496 (5,025-8,380)	73.3 (65.8-79.7)	6,340 (4,926-8,142)	71.5 (64.6, 77.6)	1,727 (1,185-2,514)	19.5 (14.2, 26.2)	938 (553-1,588)	10.6 (6.7, 16.3)	862 (491-1,510)	9.7 (6.0, 15.5)
Poverty	4,760 (3,835-5,888)	3,565 (2,806-4,516)	74.9 (62.6-84.2)	3,495 (2,746-4,435)	73.4 (61.5, 82.7)	1,338 (846-2,109)	28.1 (18.7, 39.9)	581 (354-951)	12.2 (7.5, 19.2)	443 (256-767)	9.3 (5.2, 16.0)
Education											
< High School	4,333 (3,570-5,250)	2,648 (2,055-3,404)	61.1 (48.9-72.1)	2,524 (1,910-3,325)	58.2 (44.4, 70.9)	692 (420-1,137)	16.0 (10.6, 23.4)	377[#] (187-758)	8.7 (4.7, 15.6)	327[#] (166-643)	7.6 (4.1, 13.6)
High School	4,520 (3,279-6,183)	3,560 (2,436-5,159)	78.8 (67.1-87.1)	3,544 (2,422-5,145)	78.4 (66.9, 86.7)	960 (549-1,673)	21.2 (12.3, 34.2)	653 (355-1,197)	14.4[#] (7.5, 25.9)	576[#] (282-1,171)	12.7[#] (5.9, 25.2)
> High School	5,578 (4,412-7,034)	4,524 (3,373-6,051)	81.1 (70.6-88.5)	4,444 (3,363-5,857)	79.7 (70.8, 86.4)	1,519 (1,019-2,260)	27.2 (19.3, 36.9)	617[#] (308-1,232)	11.1 (5.9, 19.7)	552[#] (254-1,194)	9.9[#] (4.9, 18.9)
TB contact											
No	13,028 (10,944-15,486)	9,438 (7,686-11,573)	72.4 (66.2-77.9)	9,359 (7,613-11,488)	71.8 (65.6, 77.3)	2,661 (2,001-3,536)	20.4 (16.7, 24.7)	1,251 (834-1,875)	9.6 (6.7, 13.6)	1,103 (696-1,747)	8.5 (5.5, 12.7)
Yes	949 (584-1,541)	906 (537-1,527)	95.5 (75.5-99.3)	754 (379-1,497)	79.5 (34.0, 96.7)	396[#] (171-916)	41.8[#] (1.9, 96.4)	288[*#] (111-749)	30.4[*#] (7.5, 70.1)	256[*#] (92-712)	27.0[*#] (6.3, 67.2)

Popn = population

CI = confidence interval

TB = Tuberculosis

[*] = raw cell size is ≤ 10

[#] = Relative standard error > 30%

QFT= Quantiferon® Gold-in-tube

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Table 3.

Factors associated with self-reported previous LTBI testing and diagnosis among persons with positive QFT result[†]

Factor	Testing for LTBI		Diagnosis of LTBI	
	Unadjusted OR (95% CI)	**Adjusted OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)[^]**
Sex				
Male	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Female	2.17 (1.35-3.48)	**2.39 (1.44-3.95)**	1.12 (0.52-2.45)	1.14 (0.51-2.56)
Age group				
6-14	0.32 [*] (0.10-1.02)	0.56 [*] (0.16-1.92)	0.70 [*] (0.09-5.32)	1.09 [*] (0.10-11.40)
15-24	0.53 (0.16-1.73)	0.42 (0.12-1.44)	0.30 [*] (0.06-1.52)	0.29 [*] (0.05-1.61)
25-44	1 (ref)	1 (ref)	1 (ref)	1 (ref)
45-64	1.23 (0.68-2.23)	1.16 (0.59-2.30)	1.88 (0.79-4.46)	2.12 (0.91-4.96)
65+	1.12 (0.68-1.83)	1.18 (0.59-2.38)	1.59 (0.69-3.66)	2.18 (0.71-6.69)
Race/ethnic group				
White	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Non-Hispanic Black	1.51 (0.71-3.23)	1.54 (0.62-3.79)	2.21 (1.26-3.88)	1.90 (0.97-3.73)
Hispanic	0.45 (0.26-0.79)	0.98 (0.47-2.05)	0.92 (0.51-1.67)	0.94 (0.38-2.34)
Asian	0.40 (0.19-0.83)	0.54 (0.20-1.42)	1.49 (0.74-3.00)	1.31 (0.58-2.99)
Other	1.08 [*] (0.42-2.78)	1.40 [*] (0.57-3.44)	0.20 [*] (0.02-2.11)	0.34 [*] (0.04-2.84)
Nativity				
U.S.	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Non-U.S.	0.45 (0.27-0.76)	0.53 (0.25-1.13)	1.05 (0.66-1.68)	1.15 (0.53-2.50)
Income				
Poverty	0.96 (0.55-1.66)	1.29 (0.72-2.31)	1.68 (0.78-3.60)	2.50 (1.00-6.26)
Non-poverty	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Education				
< High school	0.42 (0.21-0.85)	0.42 (0.17-1.04)	1.03 (0.39-2.70)	0.72 (0.24-2.17)
High school graduate	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Beyond high school	1.32 (0.64-2.71)	1.64 (0.78-3.42)	1.40 (0.60-3.24)	1.56 (0.58-4.24)
Contact of TB case	4.90 [*] (1.38-17.33)	**3.74 [*] (1.18-11.85)**	2.74 [*] (0.79-9.46)	2.57 [*] (0.71-9.28)

* indicates that at least one raw cell count was 10 or fewer in the numbers who were/were not tested or were/were not diagnosed .

† Table is restricted to survey participants who did not report prior TB disease

^ No variables were significantly associated with LTBI diagnosis in the adjusted model

Table 4.

Self-reported Testing and Diagnosis of LTBI among Key Risk Populations

Key population	Popn x1,000 (95% CI)	No. tested x1,000 (95% CI)	% tested^ (95% CI)	No. knew x1,000 (95% CI)	% knew^ (95% CI)	No. diagnosed x1,000 (95% CI)	% diagnosed^ (95% CI)
Contacts	**6,732 (5,245-8,627)**	**5,799 (4,382-7,663)**	**86.1 (73.3-93.4)**	**5,123 (3,813-6,873)**	**76.1 (64.9-84.6)**	**768 (447-1,320)**	**11.4 (6.7-18.8)**
Current LTBI	949 (584-1,541)	906 (537-1,527)	95.5 *(75.5-99.3)	754 (379-1,497)	79.5 (34.0-96.7)	396 #(171-916)	41.8 *# (1.9-96.4)
No Current LTBI	5,783 (4,495-7,432)	4,893 (3,649-6,551)	84.6 *(69.2-93.1)	4,369 (3,179-5,995)	75.5 (61.4-85.7)	372 #(179-773)	6.4 *# (3.3-12.1)
Non-US-born	**39,219 (38,799-39,444)**	**24,754 (22,309-27,050)**	**63.1 (57.0-68.8)**	**23,685 (21,177-26,072)**	**60.4 (54.2-66.3)**	**3,690 (2,979-4,550)**	**9.4 (7.6-11.6)**
Current LTBI	6,084 (5,183-7,109)	4,038 (3,453-4,709)	66.4 (56.6-74.9)	4,024 (3,444-4,688)	66.1 (56.1-74.9)	1,257 (980-1,608)	20.7 *(16.5-25.5)
No Current LTBI	33,135 (31,858-34,240)	20,716 (18,206-23,198)	62.5 (55.9-68.7)	19,662 (17,129-22,200)	59.3 (52.7-65.7)	2,433 (1,908-3,091)	7.3 *(5.7-9.5)

LTBI = Latent Tuberculosis Infection

Popn = population

CI = confidence interval

TB = Tuberculosis

* = $p < 0.05$ (LTBI compared to No LTBI group)

= Relative standard error > 30%

^ = Percent of total population of each type (in that specific row)