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ORIGINAL PAPER

Latent Tuberculosis Infection Beliefs and Testing and Treatment Health Behaviors Amongst Non-US-Born South Asians in New Jersey: A Cross-Sectional Community Survey

Navaneeth Narayanan[1,2,3] · Nupur Gulati[3] · Bishakha Ghoshal[3] · Kristina Feja[3,4] · Amisha Malhotra[3] · Rajita Bhavaraju[5] · Arpita Jindani[5] · Sunanda Gaur[3] · Sabah Kalyoussef[3,4]

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Abstract

Latent tuberculosis infection (LTBI) remains a problem in the United States as reactivation leads to active TB disease particularly in persons with risk factors. The objective of this study is to assess the knowledge, attitudes and health behaviors related to testing and treatment of LTBI among non-US-born South Asians (SA) in New Jersey (NJ). A cross-sectional, community-based survey was the primary tool for gathering data. Eligibility criteria included being at least 18 years of age, self-identifying as SA, verbal consent for participation, and birth in a high TB endemic country. A hardcopy survey was distributed at local South Asian health fairs. The survey included questions about demographics, knowledge, beliefs on TB, and health behaviors (testing and treatment). Descriptive statistics were performed for all survey responses. Logistic regression models were constructed to assess the association of characteristics/beliefs and study outcomes. The survey sample size included 387 respondents. A total of 197 (54%) of respondents reported ever been tested for TB. Those who were tested for TB were generally younger, had higher educational levels, higher household incomes, and were more likely to have health insurance than those not ever tested for TB. Significantly more respondents who self-reported ever been tested for TB believed that TB was very or extremely serious (71.1% vs. 56.2%, $p=0.004$). Also, significantly more respondents who self-reported ever been tested for TB believed that it was important to get tested (91.2% vs. 63.3%, $p<0.001$). The survey analysis concluded that high-risk SA residents in NJ demonstrated a low rate of testing for TB.

Keywords Latent tuberculosis · South Asian · LTBI testing · LTBI treatment · Health beliefs · Health behaviors

Introduction

Tuberculosis (TB), generally known as a disease of poverty [1, 2], is a global epidemic that results in the most deaths worldwide directly caused by a single infectious agent. Each year there are over 10 million new TB cases and approximately 1.6 million deaths globally. This exceeds the global death toll due to HIV/AIDS and malaria combined [3, 4]. An important aspect in the fight against TB is to diagnose and treat latent TB infection (LTBI) [5, 6]. LTBI is asymptomatic and is defined as a state of persistent bacterial viability, under immune control, with no evidence of clinically manifested active TB disease. Approximately 5–15% of those with LTBI will develop active TB in their lifetime [7]. Contemporary mathematical models estimate approximately 1.7 billion people globally have LTBI (one-quarter of the global population) [7, 8].

✉ Navaneeth Narayanan
navan12@pharmacy.rutgers.edu

1 Rutgers University, Ernest Mario School of Pharmacy, 160 Frelinghuysen Road, Piscataway, NJ 08854, USA

2 Rutgers School of Public Health, 683 Hoes Lane West, Piscataway, NJ 08854, USA

3 Rutgers Robert Wood Johnson Medical School, 1 Robert Wood Johnson Place, New Brunswick, NJ 08901, USA

4 The Children's Hospital at St. Peter's University Hospital, 254 Easton Avenue, New Brunswick, NJ 08901, USA

5 Global Tuberculosis Institute, Rutgers University, 225 Warren Street, Newark, NJ 07103, USA

The burden of LTBI remains a problem in the United States (US), a low TB-incidence country, given that reactivation of LTBI accounts for most new TB cases with the rate being higher among non-US-born persons than among US-born individuals [7, 9]. In a nationally representative study by Mancuso et al., the estimated prevalence of LTBI in the United States in 2011–2012 was 4.8% which is approximately 13.6 million individuals [10]. Non-US-born Asians have the highest rate of LTBI in the US compared to all other race/ethnicities regardless of birthplace. Additionally, TB cases due to reactivation among non-US-born Asian persons is the highest in comparison to all other non-US-born race/ethnicities [9].

The most recent estimates in 2017 by the Centers for Disease Control and Prevention (CDC), place New Jersey (NJ) in the top ten states in the country for highest incidence of TB. Among non-US-born persons, the highest incidence of TB was among Asians (27.0 cases per 100,000) as compared to all other race/ethnicities [11]. Stennis et al. [12] compared the characteristics of South Asia-born persons with TB with other non-US-born persons with TB living in New York City with the goal of assessing the TB burden among the South Asian population compared to other ethnic groups. There was high diversity among the TB strains that infected the South Asian group, suggesting that most of the South Asian persons with TB were infected outside the US as opposed to being infected as a result of local transmission within New York City.

Although some non-US born groups are of lower socioeconomic status compared to US born counterparts, areas in NJ where non-US-born Asian and South Asian persons with TB live have higher educational attainment, less household crowding, and higher income than areas in NJ where US-born persons with TB live [13]. Characteristics among South Asian persons with TB may differ from the typical TB risk factors. In a study by Asghar et al., compared to other non-US-born persons with TB, South Asians were younger, more likely to have extrapulmonary TB, more likely to be uninfected with HIV, and less likely to be homeless or use drugs or excess alcohol [14]. Overall South Asian individuals may not possess some risk factors for TB in the US such as poverty, thus requiring physicians to be more aware of risk based solely upon non-US-born status and race/ethnicity.

Following testing and diagnosis with LTBI, treatment completion is key for TB control efforts. As reported by Alsdurf et al., the steps in the cascade of care for LTBI associated with the most loss to follow-up include completion of testing for those intended for screening (72%), completion of medical evaluation if the test was positive (44%), provider recommendation for treatment (35%), and completion of treatment if started (19%) [15]. Overall there is a significant need to improve the cascade of care for LTBI to enhance TB control globally and in the US.

New Jersey has the highest percentage of Asian Indians among US states and one of the most by absolute count (many non-US-born), making them a key target for population health interventions. The US Preventive Services Task Force (USPSTF) recommends all asymptomatic adults at increased risk for infection be screened for LTBI—this includes persons born in or former residents of countries with increased TB prevalence (e.g., India) [5]. LTBI screening is recommended but not mandatory in many high-risk persons (e.g. mandated for incoming immigrants or by occupational risk but not for adults who travel to and from endemic countries). As noted earlier, identification, linkage to care, and completion of treatment is a difficult task for individuals with LTBI. Additionally, many that are non-US-born frequently travel back to their country of origin to visit friends and relatives (VFRs) [16]. Although travelers to TB endemic countries who VFRs are not a group explicitly noted by USPSTF to be candidates for TB screening upon return [5], they likely experience a higher risk of TB exposure given the close contact with local populations. Some experts recommend testing for TB 3 to 6 months after returning from travel if there is a prior negative pre-travel TB test and an extended stay (> 3 months) [16].

The objective of our study is to assess the knowledge, attitudes, and health behaviors of the NJ non-US-born South Asian community as it relates to testing and treatment of LTBI. South Asians are of particular interest for us given their high concentration in NJ and the data discussed earlier. This subpopulation among non-US-born individuals has the highest estimated prevalence of LTBI, most TB-infected South Asians in the US are infected outside the country, and South Asian persons with TB in NJ are not the "typical" case given their generally higher socioeconomic status [9, 12, 13, 17].

Methods

Study Design and Population

We performed a cross-sectional, community-based survey assessing LTBI-related knowledge, attitudes, cultural biases, and testing and treatment related health behaviors among a convenience sample of NJ South Asian community members. Eligibility criteria included self-identifying as being at least 18 years of age and as South Asian and indicating verbal consent for participation. South Asian was defined as anyone who was born in or whose family is originally from Bangladesh, Bhutan, India, Nepal, Pakistan, the Maldives, Afghanistan or Sri Lanka. The final analytic sample included "high-risk" individuals—those that were born in a high TB endemic country [5]. This study and survey content and procedures were approved by the Rutgers University and

St. Peter's University Hospital Institutional Review Boards (IRB).

Survey Methods

An anonymous self-administered hardcopy survey instrument was developed by a multidisciplinary team utilizing constructs from the Health Belief Model including perceived susceptibility, severity, benefit, barriers, and cues to action [18]. Additionally, the survey content was reviewed with experts in the TB field. Surveys were distributed at locations throughout New Jersey via local community or health fairs and were self-administered by consenting respondents. We used the South Asian Total Health Initiative (SATHI), an established program at Rutgers University, and St. Peter's University Hospital as platforms through which to administer surveys to the community and obtain our convenience sample. Surveys were passed out by Rutgers SATHI and St. Peter's University Hospital team members at local community and health fairs targeting our local South Asian community throughout central and northern New Jersey. A Rutgers and St. Peter's University Hospital IRB-approved script was placed on the table for the survey administers to read when recruiting participants. The script included the verbal consent information as well as the survey instructions. Before participants were given the survey, they were read an informed consent statement that described the purpose of the study, the procedures, the risks and benefits, and the steps that would be taken to assure the confidentiality of participants. Potential participants had to verbally confirm their eligibility and indicate their consent to participate in the study before they were given the paper survey. The need for written consent from individual participants was waived by the IRB; utilization of only verbal consent for participants using a script specified by and approved by the IRB was indicated, given the minimal risk to participants in this survey-based research study. No names or other identifying information were collected. In order to address the language barriers between survey administrators from our research team and potential community participants, we interviewed and selected bilingual Rutgers undergraduate students. These students were approved by the Rutgers IRB to help us administer surveys. Surveys were self-administered but the students were utilized on an as needed basis to translate the English survey for non-English speaking respondents. Languages involved for translation included Hindi, Gujarati, Telugu, and Bengali. The survey instrument included questions about demographics, and several themes related to TB: knowledge, perceived susceptibility, perceived severity, information seeking, testing, and treatment adherence. Demographic questions included age, country of origin, income level, being born in the United States or abroad, and level of education. Knowledge questions included understanding of basic pathology, understanding of severity, differentiating between active TB disease and latent TB infection, and understanding of the importance of testing and treatment. Cultural questions included discrepancy and/or similarity between physician recommendation in South Asian country of origin vs. the United States and beliefs about transmission of LTBI. Attitude questions included beliefs about how socioeconomic factors played a role in LTBI as well as testing and treatment-seeking behaviors.

Predictor and Outcomes

The primary predictor was the perception of the importance of being tested for TB—the survey asked, "Do you believe it is important to get tested for TB?" The primary outcome assessed was the survey response that asked, "Have you ever been tested for TB?" with explanations about TB and types of TB tests earlier in the survey. The responses were recoded to be dichotomous for modeling purposes ('yes' = tested for TB and 'no/do not remember' = not tested for TB). In a subgroup analysis of only patients who self-reported ever been tested for TB, the outcome of interest assessed was the survey question "Have you ever tested positive for TB?" which had a dichotomous survey response ('yes' = positive TB test or 'no' = negative TB test).

Statistical Analysis

Data were analyzed using SAS (version 9.4). Descriptive statistics were performed for all survey responses. Continuous data were reported as means with standard deviation or medians with interquartile ranges (IQR), as appropriate. All categorical data were reported as percentages. The Student *t* test or Wilcoxon rank sum test (for nonparametric distributions) was used for comparison of continuous variables. The Chi square test was used for comparison of categorical variables. The significance level was set at a p value of < 0.05 (two-sided). Logistic regression models were constructed to assess the association of respondent characteristics and beliefs with study outcomes—ever tested for TB and ever tested positive for TB. Potential predictors for each outcome were initially identified by assessing for significant associations in the bivariate analysis as well as theoretical plausibility. Then using a backwards selection method, final multivariable logistic regression models were constructed with a significance level of 0.05 for each predictor variable to be retained in the final model during the selection procedure. Subgroup analyses among respondents with a history of TB testing was done which included descriptive statistics, inferential statistics (stratified by history of positive TB test), and logistic regression modeling.

Results

A total of 463 surveys were collected at community and health fairs between March and June 2018. Among the 463 collected surveys, 446 were completed by adults and among those, 387 indicated they were born in a high TB burden country (final analytic sample). As shown in detail in Table 1, most survey respondents were between the age of 36–60 years (44.6%), had a bachelor's degree or higher, reported a household income of at least $100,000, had health insurance, and reported India as the most frequented South Asian country of travel. Respondents reported frequent travel to a South Asian country within the last 5 years with a median of 2 visits. There were significant differences in demographic characteristics between respondents who were tested for TB or not. Those that were tested for TB were generally younger, had higher educational level, higher household income, and had health insurance. A total of 197/387 (54%) of respondents reported ever been tested for TB.

Beliefs and health behaviors (Table 2) varied by whether individuals were ever tested for TB or not. In both groups, there was a high rate of 'do not know' (> 40%) regarding the belief that BCG vaccine will protect someone from TB for their whole life (not true). Significantly, more respondents who self-reported ever been tested for TB believed that TB is very or extremely serious (71.1% vs. 56.2%, $p = 0.004$). Also, more respondents who reported that they have ever been tested for TB believed that it was important to get tested for TB as compared to those that were not ever tested for TB (91.2% vs. 63.3%, $p < 0.001$). Lastly, those who were not tested for TB were more likely to cross check with their home country doctor if a US doctor recommended TB treatment (55.9% vs. 40.2%, $p = 0.008$).

In the multivariable logistic regression model, significant predictors of ever having been tested for TB included belief about the importance to get tested for TB and reporting a positive TB test in a family member. Those who did not believe that getting tested for TB was important, were less likely to have been tested for TB (OR = 0.15; 95% CI 0.08, 0.28). A reported family member with a positive TB test was associated with a higher odds of ever having been tested for TB (OR = 3.81; 95% CI 1.70, 8.51).

In the subgroup analysis, among those who self-reported ever having been tested for TB (Table 3), there was a self-reported positive TB test for 34/154 (18.1%) of survey respondents. In the multivariable logistic regression model for this subgroup, a reported positive TB test in a family member was significantly associated with self-reported positive TB test for the survey respondent (OR = 5.41, 95% CI 2.10, 13.99). Furthermore, among those respondents with self-reported positive TB test, 16/33 (48.5%) reported having a treatment plan recommended by a physician.

Discussion

This cross-sectional survey-based study demonstrated a low rate of self-reported testing for TB in a high-risk population (born in a TB endemic country), at only 54%. As we hypothesized, the belief regarding the importance of getting tested for TB was significantly associated with ever been tested for TB even after controlling for other predictors. As with many health conditions, predictors of receiving recommended tests may include education, income, or insurance status—all related to health care access. In our study sample, those factors were found to not be predictive of a history of TB testing. Instead, an individual's belief of the importance of the test and a family member with a positive test were more predictive. A family member with a positive TB test was also a significant predictor of the survey respondent reporting ever having a positive TB test within our subgroup analysis.

Our study sample survey results were consistent with previous studies that noted non-US-born persons with TB in New Jersey generally belong to a higher socioeconomic status compared to US-born residents [13]. The respondents in our study reported high household income, high educational attainment, and high rate of health insurance coverage. Despite the higher socioeconomic status and probable high access to health care services (via health insurance coverage), there was a low rate of self-reported TB testing. Our results suggest that the perception of testing importance may play a role as to why the prevalence of testing in our sample is low. This cohort is one that is specifically recommended to be tested for LTBI given their TB endemic country of birth [5]. Additionally, over 40% of the surveyed sample reported > 2 visits to SA countries within the last 5 years representing added risk of TB exposure from their frequent travel and likely contact with the local population. Although the duration of stay is unknown, there is likely incremental added risk for this group and, therefore, an even greater need to screen for TB. The surveyed sample is highly insured, educated, and can afford frequent international travel, therefore, it is probable that a gap in knowledge persists among these individuals on the medical necessity to be screened for TB upon extended travel as opposed to barriers to medical access. Other possible reasons include cultural biases, stigma associated with TB, attitudes on the benefits of testing and treatment, or medical practice limitations (i.e., physicians not appropriately testing their high-risk patients or not asking about travel history).

Among Asians in the US in 2011–2012, the estimated prevalence of LTBI is 17% or 21.3% (dependent on the method of LTBI testing)—the highest among any race or ethnic group. Additionally, according to a study by Mancuso et al., the estimated prevalence of LTBI in the US in

Table 1 Demographics of adult South Asians born in a TB endemic country stratified by self-reported TB testing status

Variable	All respondents (n = 387)	Not tested for TB (n = 168)	Tested for TB (n = 197)	p value[a]
Age, years				
18–35	90 (23.6)	35 (21.3)	52 (26.7)	**0.045**
36–60	170 (44.6)	68 (41.5)	94 (48.2)	
>60	121 (31.8)	61 (37.2)	49 (25.1)	
Number of visits to SA countries in last 5 years				
≤2	181 (58.4)	76 (57.6)	95 (58.6)	0.854
>2	129 (41.6)	56 (42.4)	67 (41.4)	
Years of residence in the US				
≤10	77 (22.6)	38 (26.4)	34 (19.2)	0.295
11–20	79 (23.2)	33 (22.9)	42 (23.7)	
>20	185 (54.3)	73 (50.7)	101 (57.1)	
Ever travel to SA country				
India	317 (82.8)	139 (83.2)	161 (83)	0.379
Region of birth				
South Asia	379 (97.9)	165 (98.2)	192 (97.5)	0.625
Other TB endemic countries	8 (2.1)	3 (1.8)	5 (2.5)	
Highest level of education				
Less than high school	14 (3.7)	7 (4.2)	5 (2.6)	**0.005**
High school	23 (6)	13 (7.8)	7 (3.6)	
Some college	32 (8.3)	14 (8.4)	18 (9.2)	
Bachelors	148 (38.5)	70 (42.2)	71 (36.2)	
Masters	124 (32.3)	54 (32.5)	61 (31.1)	
Doctorate	43 (11.2)	8 (4.8)	34 (17.4)	
Household income				
≤ $20,000	37 (12.3)	23 (18.6)	12 (7.1)	**0.019**
$21–39,000	19 (6.3)	9 (7.3)	9 (5.3)	
$40–59,000	32 (10.6)	17 (13.7)	15 (8.8)	
$60–79,000	31 (10.3)	10 (8.1)	21 (12.4)	
$80–99,000	26 (8.6)	9 (7.3)	16 (9.4)	
$100–149,000	67 (22.3)	28 (22.6)	38 (22.4)	
≥ $150,000	89 (29.6)	28 (22.6)	59 (34.7)	
Health insurance (yes)	319 (88.6)	131 (84)	177 (92.7)	**0.011**
Tested for TB after travel to SA country				
Always	27 (12.9)	3 (12)	24 (13.6)	0.067
Sometimes	43 (20.6)	1 (4)	41 (23.3)	
Never	139 (66.5)	21 (84)	111 (63.1)	
Positive TB test by a family member				
No	286 (80.3)	131 (85.6)	146 (76.8)	**0.001**
Yes	50 (14.1)	10 (6.5)	37 (19.5)	
Do not know	20 (5.6)	12 (7.8)	7 (3.7)	
Ever been tested for TB	197 (54)			

Categorical variables described as number (percentage)

Bold values indicate statistically significant results

IQR interquartile range, *SA* South Asian

[a]Determined by Chi square test for categorical variables or Wilcoxon rank sum test for continuous variables

2011–2012 is 15.9% or 19.8% (dependent on method of testing) for non-US-born persons [10]. In another study by Miramontes et al., the TB test positivity prevalence was 15.9% (IGRA) and 20.5% (TST) in 2011–2012. These estimates are consistent with the observed self-reported TB test positivity in our study of non-US-born South Asians.

Table 2 Beliefs and health behaviors of adult South Asians born in a TB endemic country stratified by self-reported TB testing status

Variable	All respondents (n = 387)	Not tested for TB (n = 168)	Tested for TB (n = 197)	p value[a]
Belief that BCG vaccine will protect from TB for whole life				
No	74 (21.6)	28 (18.7)	42 (23.5)	0.505
Yes	123 (35.9)	54 (36)	66 (36.1)	
Do not know	146 (42.6)	68 (45.3)	74 (40.4)	
Belief about severity of TB				
Not serious	17 (4.9)	9 (5.6)	8 (4.3)	**< 0.001**
Slightly serious	25 (7.2)	12 (7.8)	12 (6.4)	
Moderately serious	62 (17.8)	31 (20.3)	30 (16)	
Very serious	153 (44)	68 (44.4)	80 (42.8)	
Extremely serious	71 (20.4)	18 (11.8)	53 (28.3)	
Do not know	20 (5.8)	15 (9.8)	4 (2.1)	
Belief about severity of TB (recoded)				
Do not know/not serious/slightly/moderately serious	124 (35.6)	67 (43.8)	54 (28.9)	**0.004**
Very/extremely serious	224 (64.4)	86 (56.2)	133 (71.1)	
Belief on spread of TB				
Hereditary	25 (7.8)	13 (10.1)	12 (6.6)	0.065
Contact with someone with TB	210 (65.4)	76 (58.9)	129 (70.5)	
Environment	47 (14.6)	24 (18.6)	20 (10.9)	
Other	12 (3.7)	7 (5.4)	4 (2.2)	
More than one method	27 (8.4)	9 (7)	19 (9.8)	
Belief if you receive BCG vaccine, you will always have positive TB test				
No	98 (29.7)	33 (23.9)	61 (33.3)	**0.007**
Yes	95 (28.8)	34 (24.6)	60 (32.8)	
Do not know	137 (41.5)	71 (51.5)	62 (33.9)	
Belief blood test for TB is more accurate than skin test if you had BCG vaccine				
No	49 (13.8)	14 (9)	32 (17)	**< 0.001**
Yes	167 (47.2)	64 (41.3)	99 (52.7)	
Do not know	138 (39)	77 (49.7)	57 (30.3)	
Belief that positive TB test means you have TB in your body				
No	89 (25)	32 (20.4)	55 (29)	**< 0.001**
Yes	132 (37.1)	41 (26.1)	89 (46.8)	
Do not know	135 (37.9)	84 (53.5)	46 (24.2)	
Belief on likelihood of contracting TB in US vs. SA country				
US	6 (1.8)	1 (0.7)	5 (2.8)	**0.035**
SA country	193 (58.5)	75 (52.1)	111 (62.7)	
Do not know	131 (39.7)	68 (47.2)	61 (34.5)	
Belief TB occurs in people from lower SES				
No	89 (25.7)	32 (21.5)	54 (28.9)	**0.006**
Yes	193 (58.5)	32 (21.5)	59 (31.6)	
Do not know	131 (39.7)	85 (57.1)	74 (39.6)	
If tested positive for TB, would you share results with family/friends (yes)	283 (91.3)	121 (90.3)	156 (92.3)	0.535
Belief that doctors in SA are more knowledgeable about treating TB than US doctors				
No	68 (19.9)	18 (12.2)	48 (26.1)	**0.003**
Yes	137 (40.1)	60 (40.8)	74 (40.2)	
Do not know	137 (40.1)	69 (46.9)	62 (33.7)	
Belief that medication will cure TB disease				
No	19 (5.4)	7 (4.6)	10 (5.3)	**0.039**
Yes	256 (75.5)	102 (67.1)	148 (77.9)	
Unsure	78 (22.1)	43 (28.3)	32 (16.8)	

Table 2 (continued)

Variable	All respondents (n = 387)	Not tested for TB (n = 168)	Tested for TB (n = 197)	p value[a]
Likely to cross check with home country doctor if US doctor recommends TB treatment	143 (46.9)	71 (55.9)	68 (40.2)	**0.008**
Willingness to get tested for TB for free	222 (63.4)	94 (63.1)	125 (65.5)	0.652
Belief that it is important to get tested for TB	281 (77.4)	100 (63.3)	176 (91.2)	< **0.001**

Categorical variables described as number (percentage)

Bold values indicate statistically significant results

BCG Bacillus Calmette–Guérin, *TB* tuberculosis, *US* United States, *SA* South Asian, *SES* socioeconomic status

[a]Determined by Chi square test for categorical variables

Table 3 Selected covariates of adult South Asians born in a TB endemic country *who were ever tested for TB* stratified by self-reported positive TB test

Variable	All respondents (n = 197)	Negative TB test (n = 154)	Positive TB test (n = 34)	p value[a]
Age, years				
18–35	52 (26.7)	44 (28.6)	6 (18.2)	0.179
36–60	94 (48.2)	76 (49.4)	15 (45.4)	
> 60	49 (25.1)	34 (22.1)	12 (36.4)	
Number of visits to SA countries in last 5 years				
≤ 2	95 (58.6)	72 (55.8)	19 (70.4)	0.163
> 2	67 (41.4)	57 (44.2)	8 (29.6)	
Years of residence in the US				
≤ 10	34 (19.2)	31 (22.5)	3 (10)	**0.049**
11–20	42 (23.7)	35 (25.4)	4 (13.3)	
> 20	101 (57.1)	72 (52.2)	23 (76.7)	
Ever travel to SA country				
India	161 (83)	129 (84.9)	27 (81.8)	0.797
Health insurance (yes)	177 (92.7)	137 (92)	33 (97.1)	0.295
Tested for TB after travel to SA country				
Always	24 (13.6)	22 (15.9)	2 (6.5)	**0.006**
Sometimes	41 (23.3)	38 (27.5)	2 (6.5)	
Never	111 (63.1)	78 (56.5)	27 (87.1)	
Positive TB test in a family member				
No	146 (76.8)	124 (82.7)	14 (43.8)	< **0.001**
Yes	37 (19.5)	22 (14.7)	15 (46.9)	
Do not know	7 (3.7)	4 (2.7)	3 (9.4)	
Belief that it is important to get tested for TB	176 (91.2)	139 (91.5)	31 (93.9)	0.635
Belief about severity of TB				
Do not know/not serious/slightly/moderately serious	54 (28.9)	39 (26.7)	10 (30.3)	0.676
Very/extremely serious	133 (71.1)	107 (73.3)	23 (69.7)	

Categorical variables described as number (percentage)

Bold values indicate statistically significant results

TB tuberculosis, *US* United States, *SA* South Asian, *SES* socioeconomic status

[a]Determined by Chi square test for categorical variables

Compared to the general US population estimates, the reported TB test positivity rate in our sample is higher (18%) than background but is relatively low based on the specific group surveyed—non-US-born adults from a high TB burden country of birth (> 90% from India). The data on LTBI prevalence within South Asian countries is limited, but generally shows higher rates than what was found in our study. For example, it is estimated that approximately 40% of the total population of India has LTBI although there is likely variation by geographic location and socioeconomic status [19]. In a pooled analysis, the pooled LTBI prevalence point estimate was 47% among healthcare workers in high burden countries while in India it was 43% [20]. Although comparisons cannot be directly made and healthcare workers, especially in high TB burden countries, are inherently at higher risk for LTBI, there is a relatively lower rate of LTBI test positivity in our sample. We hypothesize there is possibly a selection bias given that we utilized a convenience sample that may have steered away from the highest risk subgroup among South Asians. Future studies with advanced sampling methods to develop representative samples are needed both here in the US as well as in high TB burden countries such as India to accurately estimate the prevalence of LTBI.

Our study has multiple limitations that should be considered. First, as mentioned earlier, we utilized a convenience sample that included mostly Indians, therefore extrapolation to the larger US-based, non-US-born South Asian population cannot be made. There is a risk of selection bias due to the sampling method and utilizing community health fair events to capture potential survey respondents. Second, data regarding survey respondent's gender was not captured which could have allowed for assessment of differences by sex. Third, given the cross-sectional study design, temporality cannot be assessed. It is unknown whether knowledge or beliefs related to testing and treatment of LTBI preceded or followed our outcomes of interest. There is a risk for reverse causality as a result of this (e.g., receiving a TB test resulted in the belief about the importance to be tested for TB). Fourth, given the data was collected through self-reported surveys, the accuracy of testing and its results are unknown. Lastly, missing data from unanswered survey questions can lead to less power when summarizing questions and including multiple variables in the models assessing study outcomes.

Despite noted limitations, there are some strengths to our study. We were able to obtain a relatively large sample size and administer a comprehensive survey to assess knowledge and beliefs related to LTBI. There was high value in the size and breadth of survey responses as well as the relationships shown between predictors and health behavior outcomes (ever been tested for TB). Data on the New Jersey South Asian population are limited, so our study adds key data to the body of literature on potential disease prevention interventions and TB control targets. We were able to access a high-risk population and elucidate a better understanding of their knowledge, attitudes, and health behaviors. Lastly, we were able to perform regression modeling to conduct an exploratory analysis to assess for predictors of study outcomes. This better allows for designs for future health promotion interventions to improve rates of LTBI testing and treatment in this population.

The public health implications of our work are significant. We live in a time in which health, particularly that impacted by infectious disease, is highly dependent on the movement of people, and as a result, the movement of pathogens. Health is also highly dependent on the understanding of the world as a diverse place with regards to disease burdens and country-specific health regulations. It is important to recognize that TB endemic countries are focused on TB disease control. On the other hand, non-endemic countries are focused on disease eradication, specifically by identifying, testing, and treating LTBI. For this reason, the population who would benefit the most from the results of our findings from this study is South Asian immigrants, particularly those who travel often to and from their South Asian country of origin; where they are potentially exposed to TB bacilli. We plan to use the results of this study to help shape our intervention in the targeted community about the importance of screening for and treatment of LTBI.

In summary, our cross-sectional study of South Asian New Jersey residents born in high TB burden countries demonstrated a low rate of testing for TB and belief regarding the importance of TB testing was significantly associated with getting TB testing. Future studies are needed to evaluate the impact of health promotion programs on rates of testing and treatment for LTBI for South Asian and other high-risk non-US-born populations.

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Compliance with Ethical Standards

Conflict of interest The authors have no conflicts of interest to report relevant to this publication.

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