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Christine E. Miner Date

Faith-based Social Capital, Racial Trust, Community Support of Immigrants' Rights and Risk of Tuberculosis in Selected Metropolitan Statistical Areas, 2000 and 2006.

By

Christine E. Miner

Degree to be awarded: MPH

Epidemiology

_____

Michael Kramer, PhD

Committee Chair

Faith-based Social Capital, Racial Trust, Community Support of Immigrants' Rights and Risk of Tuberculosis in Selected Metropolitan Statistical Areas, 2000 and 2006.

By

Christine E. Miner

Bachelor of Science

Clemson University

2009

Thesis Committee Chair: Michael Kramer, PhD

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Abstract

Faith-based Social Capital, Racial Trust, Community Support of Immigrants' Rights and Risk of Tuberculosis in Selected Metropolitan Statistical Areas, 2000 and 2006.

By Christine E. Miner

Purpose: Since 2002, Foreign-born individuals represent the majority of Tuberculosis (TB) cases in the United States. Risk factors associated with the U.S. and Foreign-born populations include living conditions, occupation, socioeconomic status, biological risk factors and country of origin, for the Foreign-born population alone. However, few studies have examined the association between other social determinants of health and TB, especially in the Foreign-born population. This study will provide information on the association between TB case rates in Metropolitan Statistical Area's (MSA's) and MSA-specific faith-based social capital, racial trust and support of immigrants' rights. Faith-based social capital is the resources one receives from being a member of a religious community.

Methods: Two public use datasets were used in this analysis. First, the *Online Tuberculosis Information System* (OTIS) contains data on all verified cases in the United States and Pacific Islands from 1993. However, only two demographic variables could be stratified for at a time due to suppression of cross-classified surveillance data. The *Social Capital Community Benchmark Survey*, which contains data from a random sample of citizens in 42 designated communities, was used to create a contextual measure of the degree of social capital in each MSA. Analyses performed included descriptive statistics and Poisson regression of correlated data.

Results: A 1-standard deviation increase in MSA-specific faith-based social capital was associated with a 1.54 increase in rate for diagnosis of TB in selected MSAs after adjusting for race, sex and year (p=0.03). This finding was similar in three models that adjusted for U.S./Foreign-born status and year (RR: 2.01, p=0.06), U.S./Foreign-born status, race and year (RR: 1.63, p=0.01), and U.S/Foreign-born status, sex and year (RR: 3.81, p=0.01). Decreased support of immigrants' rights was also associated with increased TB case rates, in two models that adjusted for sex (RR: 2.21, p=0.02), and age and sex (RR: 1.91, p=0.06).

Conclusion: MSA-level decreased support of immigrants' rights and faith-based social capital were associated with increased TB rates. More studies should be conducted to replicate these findings, and if replicated, interventions could be designed to further decrease TB case rates in the United States.

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Table of Contents

List of Tables

Descriptive Statistics

Poisson Analysis of Correlated Data

Introduction:

Since 2002, the majority of tuberculosis (TB) cases in the United States have been among those born outside the U.S. and its territories, with many of these immigrants being from countries of high-TB incidence. Social determinants of health such as geographically varying community social capital and healthcare safety net resources are one set of factors which may further our understanding of excess TB rates among immigrants. Social capital is the resources one gains from being a member in a social network. Persons with more social capital may be more likely to receive treatment for either active or latent TB infection if they feel more involved in their community and also may be due to individuals being more aware of healthcare opportunities. A study examining the effects of social capital on TB case rates has been done previously, but no studies to date have looked at the association between immigrants' TB status, social capital, racial distrust, and the community's views of immigrants (1). These findings may be different for Foreign-born individuals, as previous studies have shown that concerns about immigration status have caused foreign-born individuals to delay medical care. Thus, communities unwelcoming to immigrants could be at greater risk for increased TB cases amongst immigrants.

The *Online Tuberculosis Information System* (OTIS) is a public-use dataset that uses TB case information collected by the CDC since 1993, on an annual basis, throughout the United States and its territories. TB is a required reportable disease in the United States, thus the OTIS system gives the most valid and currently available population based representation of TB cases each year. Of main interest to this study is information collected on TB-case immigration status and metropolitan statistical area (MSA). In addition, the *Social Capital Community Benchmark Survey Dataset*,

conducted by the Roper Center, in 2000 and 2006 will be used for analysis. The *Social Capital Community Benchmark Survey* was designed to better understand social capital and participants' views of their communities, and performed by a random sample of citizens in communities across the United States. In 2000, 41 communities were sampled, and in 2006, 22 communities were sampled. Of these communities, 25 MSAs in the 2000 dataset and 6 MSAs in the 2006 dataset will be used due to the OTIS dataset only containing the 100 most populous MSAs. These two datasets will be merged to better understand the effect of social capital, racial distrust, and a community's views of immigrants on immigrants' TB status.

Background and Literature Review

Overview

Tuberculosis is caused by the bacteria *Mycobacterium tuberculosis* and infects an estimated one-third of the world's population. Tuberculosis (TB) case rates have been dropping in the United States since 1992 from 10.4 cases per 100,000 to 3.8 cases per 100,000 in 2009 (4). Since 2002, the majority of TB cases in the United States are among those born outside the U.S. and its territories, with many of these foreign-born individuals originating from countries of high-TB incidence. In 2009, the case rate for U.S-born individuals was 1.7 cases per 100,000, while the case rate for foreign-born individuals was 18.7 cases per 100,000 (4).

Biology

Tuberculosis (TB) is caused by *Mycobacterium tuberculosis* which is a rod-shaped, aerobic, gram positive, and acid fast bacterium (5). *M tuberculosis* can cause either active or latent infection depending on the host's immune status, with the latent infection (LTBI) being the most common form (5, 6). A person with LTBI is not contagious and will not show symptoms of TB infection. However, a person with LTBI can undergo reactivation, or converting from LTBI to active TB infection, due to immune system alterations (7). Yet, only about 5-10% of those with LTBI will develop an active TB infection (6). After undergoing reactivation, active TB infection will cause symptoms which may consist of coughing with or without blood, chest pains when breathing, lethargy, weight loss, or fever (7). In addition, those suffering from active TB infection can transmit their disease to others. Finally, Extrapulmonary TB may be diagnosed if *M tuberculosis* is found anywhere in the body except the lungs.

To establish infection, *M tuberculosis* bacteria must be inhaled, usually from a cough of a person with active tuberculosis infection. Once inhaled, the bacteria travel to the lungs, where the primary infection stage begins (7). Once in the lungs, the bacteria are phagocitized by macrophages, and the bacteria survive by altering the macrophage's phagosome and lysosome functions (7, 8). Next, mononuclear cells and other cells are recruited to form the granuloma, which works to contain the *M tuberculosis* bacteria (7, 8). The granuloma consists of lymphatic infiltrate, giant cells, foamy macrophages, granulocytes and macrophages that have *M tuberculosis* living within them (7, 8). LTBI occurs when the granuloma succeeds in keeping the bacteria sequestered (7, 8). Conversely, if the granuloma decays and releases the Mycobacteria, due to immune system changes, active TB infection will occur (7, 8).

Risk Factors

Much research has been done to understand the risk factors associated with the development of tuberculosis (TB) disease. Most risk factors have been found to be associated with transmission or immune system disturbances, often by causing reactivation of a latent tuberculosis infection (LTBI) (7). However, the exact causes leading to reactivation of TB, going from LTBI to active infection, are still not known (7). Risk factors associated with TB can be divided into two categories: biological and social determinants.

Biological Determinants

Biological factors are risk factors that are related to either the pathogen's or host's biology. As with other infectious diseases, certain genotypes of the infectious agent are

more virulent than others. For example, the Beijing strain of *M tuberculosis* is more virulent than other strains of *M tuberculosis* (8). Genetics also plays a role in the development of disease within the host, as hosts differ in their susceptibility to TB infection due to intrinsic qualities (5, 9). In addition to genetics, both age and sex are associated with development of TB infection. Similarly to many infectious diseases, the old are more likely to become infected after exposure to TB disease than those who are young adults and adults, due to decreased immune system function (5, 10, 11). Gender is also associated with TB transmission, with men being more likely to be diagnosed with TB infection (4, 12, 13). Molecular epidemiological studies have shown that men tend to be isolated TB cases, whereas women are more likely to be a member of a cluster of TB cases (9). However, societal issues may partially explain this difference, as men, depending on culture, may be more likely to leave the home and become exposed to those with TB, than women (12).

Diabetes, end-stage renal disease, immunosuppressive drugs, HIV, and malnutrition are all biological risks for active TB. Many of these risk factors affect the immune system, usually by altering T-cell response or IFN- γ production (15-17). Patients with diabetes are more likely to develop TB than those without diabetes, especially for patients that poorly control their disease (16). In addition to diabetes, patients with end-stage renal disease are more likely to develop TB than those not suffering from end-stage renal disease (19). Consuming immunosuppressive drugs, including drugs used in cancer treatment, has also been found to be associated with an increased risk for the development of TB (20). Besides data showing that HIV patients are more susceptible to TB infection, it has also been shown that TB may increase

immunosuppression in those with HIV co-infection (15, 17, 20). Malnutrition, more specifically Vitamin D deficiency, has also been shown to increase the risk of developing TB, and this is due to Vitamin D's role in macrophage activity (21).

Social Determinants of Tuberculosis

Social determinants of health relate to how a person's environment, either economic or social, helps to establish their health outcomes. TB has long been associated with social determinants of health, as TB infection was often associated with those living in poverty (22). Social determinants of health that have previously been found to be associated with TB include living conditions, behavioral risk factors, socioeconomic status, ethnicity, immigration, and social capital.

The relationship between living conditions and TB has long been known. Living in urban settings has been identified since the 1800s as a risk factor for developing TB, with those living in urban conditions being more likely to be diagnosed with TB than those living in rural areas (15, 20). This may be due to urban area residence being the summation of multiple risk factors associated with the development of TB. Another risk factor associated with living conditions is residing in a crowded residence, and is due to TB transferring more readily between people in close contact (15, 23). Living in places with large proportions of vulnerable populations, such as homeless shelters, prisons, and long-term care facilities, is also associated with an increased risk of TB for similar reasons (15, 20). However, other factors, such as weakened immune system or drug use, may also play a role in the development of TB in these populations as well (15). Furthermore, poor ventilation has been associated with TB transmission (15, 20). Poor

ventilation allows *M tuberculosis* to float in the air longer than in well ventilated areas, allowing for a greater chance of inhalation (20). Air pollution and smoke inhalation, of all forms, have been associated with the development of TB, due to irritation of the lungs (24, 25). Living conditions partially explain TB case rates, but other social factors play an important role as well.

Behavioral risk factors, specifically drug use, both injecting and non-injecting, cigarette smoking, and alcoholism have all been found to be associated with the development of TB, and there are a few explanations for the observed relationships (15, 26). First, drug use impairs the body's ability to fight infections, through various mechanisms such as altering immune system cells (27). Another explanation pertains to the living conditions of drug users (27). Often, drug users live in worse conditions than those not using drugs. These living conditions may include poor ventilation or crowding, which are also risk factors associated with TB. Alcoholism has also been associated with an increased risk for the development of TB and is thought to cause changes in T-cell proliferation (26, 27). Similarly to drug users, living conditions may also be a factor in alcoholics' increased risk of TB infection (26). Thus, drug and alcohol use increases the risk of developing TB, due to both biological reasons and societal conditions.

Socioeconomic indicators, including socioeconomic status (SES), education and occupation, also have a relationship with TB. Lower SES has been associated with increased risk of developing TB, and this relationship has been seen throughout history (15, 20,22-24, 28, 29). The relationship between lower SES is partially explained by access or availability of medical care, as those with lower SES often have less access or availability to medical care than those of higher SES (20, 22). Often, low SES limits a

person's ability to obtain medical insurance, and areas containing large populations with low SES often have limited access to medical services, such as medical clinics. Relevant to this study, is the observed relationship between income inequality and social capital. Studies have found that areas with large income inequality often have less social capital than areas with more equal income and have worse health outcomes (30). Kawachi states that this may be due to the decrease in sociability, trust and reciprocity in these areas (30). In addition, education has also been associated with the risk for the development of TB, with those who are less educated being more likely to develop TB than those who received more education (23, 25). Finally, certain careers, mainly those in contact with high risk populations, such as drug users and the homeless, are at an increased risk for the development of tuberculosis (22). These occupations include healthcare workers, correctional facilities workers, and migratory/ agricultural workers. Socioeconomic status, education and certain careers have all been associated with an increased risk for the development of TB.

Tuberculosis has been found to be associated with race, ethnicity and country of origin. Minority populations are more likely to have TB compared to the White, non-Hispanic population in the United States (15, 20, 22, 31). Molecular epidemiologists have found that the transmission of TB differs by race. For the U.S.-born population, African-Americans have the highest rates of TB, and most African-American TB cases represent clustered, recently transmitted cases (4, 11). For the Foreign-born population, Asians are more likely to be diagnosed with TB than other races or ethnicities (4). Foreign-born Asian cases are usually not clustered (11). The differences seen in TB rates between the White, non-Hispanic population and minority populations may be partially explained by

racism. Many studies have found that those who reported racism were more likely to suffer from a variety of diseases (32-34). In addition, disadvantages propagated by structural racism has put certain minority populations in greater jeopardy for risk factors previously discussed, such as homelessness, drug use, lower SES, and incarceration (33, 34) .

Since 2002, a majority of TB cases reported in the United States are due to those born outside the U.S. and its territories. However, this is not due to increased numbers of Foreign-born individuals living in the U.S., as TB rates among Foreign-born individuals have been decreasing since 1995 (4, 35). TB cases among Foreign-born individuals are characterized by clustered strains not commonly found in the U.S (35). Thus, most TB transmission appears to occur among Foreign-born individuals, not between Foreign-born and U.S.-born individuals (23, 28, 37). In addition, reactivation of LTBI is often the origin of most cases in Foreign-born clusters, with the source case usually becoming infected with TB while living in their country of origin (23, 28). Reactivation is more common in those who have lived in the U.S. for 5 years or less (37).

The risk factors associated with increased TB in the Foreign-born population are often not similar to risk factors found in the general U.S. population. For example, country of origin is associated with increased risk for the development of TB, as countries of high TB prevalence represent more cases of TB in the United States than cases of individuals from countries of low TB prevalence (37-39). Risk factors for the Foreign-born population include social customs, language barriers, fear of immigration authorities, stigma associated with TB, socioeconomic factors, and occupation.

Societal issues have also affected the Foreign-born population's risk for the development of TB. Social customs are thought to play a role in the increased TB rates of immigrants, as certain cultures are more likely to welcome close contact between individuals, allowing for the increased likelihood of TB transmission (40). As mentioned previously, in some cultures, women are more likely to stay in the home, while men are more likely to go outside the home for work and socializing, putting men at greater risk for transmission of TB (14). In addition to cultural differences, immigrant's fears regarding their own immigration status appear to be associated with delays in seeking healthcare, and delays in seeking healthcare may be associated with increased disease transmission or severity (41). One study by Asch, specifically examined whether immigration concerns affected healthcare seeking behaviors. The authors found that 20% of immigrants delayed care, once exhibiting symptoms, for more than 60 days, and those less proficient at the English language delayed care longer than those with proficient English language skills (41). In addition, of those who were afraid of immigration authorities, 47% delayed seeking medical care because of immigration issues, compared to 18% of those who did not fear immigration authorities (41). Delay of care allows for greater TB transmission, as those with active TB infections have a longer infectious period. A review in New Zealand found that settlement issues, which included racial discrimination, language barriers, lack of social support and unemployment, were predictors of active TB disease (42). The same study also stated that immigrants who feared their immigration status would be affected if they attended a health clinic may be less likely to obtain health care (42). The social stigma of TB has also been implicated as a reason for decreased healthcare seeking behaviors in the Foreign-born population (40,

42, 43). Thus, there are many factors that appear to affect the association between immigrants and increased TB rates.

While there are many unique risk factors for the development of TB in Foreign-born populations, there are several social determinants of health that are experienced similarly by U.S. and Foreign-born populations including socioeconomic status (SES), living conditions, and occupation. Foreign-born individuals are twice as likely to live below the poverty status compared to U.S.-born individuals (44). As stated previously, low SES limits the availability and access to medical care. In addition, Foreign-born individuals are more likely to live in crowded conditions, compared to the U.S.-born population, and living in crowded conditions has been associated with increased risk for TB development (45). Finally, migrant farm workers are at a greater risk for the development of TB compared to other occupations. This is partially due to migrant farm workers delaying medical care when showing symptoms of TB, causing a longer infectivity period (47).

A final hypothesized social determinant of health that has been associated with TB is social capital. Social capital is the resources a person obtains from being a member in a community and has been shown to be related to various aspects of health (30, 48). Components of social capital often include the measures of group membership, interpersonal trust, and social cohesion (48). Kawachi, I and Berkman, L. have proposed that social capital influences health outcomes by three factors (48). First, social capital may have an effect on individuals' reception of positive health behaviors (48). Thus, a person may be more likely to receive medical care, not only for concern about themselves, but also about how their health influences their community. In addition,

social capital may influence access to healthcare resources, as individuals may be more aware of the location and services offered by local healthcare organizations through involvement in the community (48). Finally, it is proposed that social capital may shape psychosocial processes (48). Studies have found that communities with low interpersonal trust also have low trust in public institutions, such as public health clinics (48). For example, an immigrant may forgo healthcare, due to fears about their immigration status. In addition, social cohesion, or the connections that bring the individuals from various backgrounds in a community together, has also been associated with better health outcomes (49). Finally, prolonged stress has been associated with negative health outcomes, specifically in the hypothalamic-pituitary-adrenal axis (HPA) (49). Increased cortisol secretion has been associated with decreased immune system function, but this has been mainly observed in regards to social support (49). However, social capital and social cohesion may influence the social support one receives, and thus may indirectly influence immune system function.

Only one study has examined the association between TB and social capital and found an inverse relationship between social capital and TB rates (1). Thus, the more connected a person is to others and their community, the less likely they are to develop TB. However, this study used data aggregated at the state level and used several indirect measures of social capital, such as the number of non-profit organizations in the state (1). While there is only one study looking at the association between social capital and TB, others have examined the effects of social capital on cases of other infectious diseases. Gonorrhea, Syphilis, Chlamydia, and AIDS case rates were shown to be inversely associated with social capital, similarly to TB (50). In addition, chronic diseases, such as

hypertension and self-reported health, have also been inversely related to social capital (48, 51).

Importance of Study

While large decreases in tuberculosis (TB) rates in the U.S.-born population have been seen, such decreases have not been observed in the Foreign-born population, hindering the goal of TB elimination in the United States. Only one study has examined the relationship between social capital on TB case rates of the U.S.-born population, and no studies have looked at this association in the Foreign-born population (1). In recent years, much attention has focused on the immigrant community in the U.S., with some individuals even calling for immigration to the U.S. to end. These negative attitudes towards immigrants may cause communities to become less trustworthy and open to immigrants belonging in their community than previously. This, in turn, may cause an increase in immigrants' stress, decrease immigrants' access to community organizations, decrease availability of jobs, and other negative consequences. Overall, these negative factors may put Foreign-born persons at greater risk for the development of TB because of previously stated risk factors including poor living conditions, low socioeconomic status (SES), and increased delays in seeking healthcare.

Thus, to achieve the goal of eliminating TB in the U.S., a reduction of TB case rates in the Foreign-born population must occur. Obtaining this reduction will happen by understanding the total experience of Foreign-born persons in the U.S., especially in regards to social determinants of health. Once the mechanisms leading to increased TB in immigrants are learned, interventions can be devised to reduce barriers to healthcare in the immigrant population. Immigrants may be more likely to receive medical care and

undergo less stress if these obstructions are removed. In addition, communities may take steps to make immigrants feel more welcome, which will hopefully increase immigrants' social capital.

Research Questions/Null Hypothesis

There are three questions of interest:

1. To understand the effects of faith-based social capital on tuberculosis rates in the U.S.- and Foreign-born population

2. To understand the effects of racial trust on tuberculosis rates in the U.S.-and Foreign-born population

3. To understand the effects of a community's belief about immigrants on tuberculosis rates in the U.S.- and Foreign-born population

Methods

Data Sources

2000 and 2006 Social Capital Benchmark Survey

The *Social Capital Benchmark Survey* was conducted in 2000 and 2006 by the Roper Center for Research, with the goal of better understanding social capital (2). The 2000 dataset consisted of 41 communities, and the 2006 dataset contained information about 22 communities, with certain communities included in both datasets (2). To conduct the survey, a random sample of participants was obtained through random-digit-dialing in each community. Over-sampling and subsequent weighting did occur in certain areas, and was done mainly insure adequate sample size in certain ethnic groups (2). A respondent from each household was chosen if they were 18 years or older (2). The interview took on average 26 minutes to complete, and some questions were modified specifically to the respondent's community (2).

From each survey, variables of interest included geographic information, individual's support of immigrants' rights, faith-based social capital, and inter-racial trust. Geographic variables included Metropolitan Statistical Area (MSA) information, for the 2000 dataset, and state information, for the 2006 dataset (2, 52). The state variable was used in place of the MSA variable for the 2006 dataset, as the 2006 dataset did not include information regarding MSA (52). The state variable could be used, as all states included in the analysis contained information on only one major MSA (52). In addition, 2006 data was analyzed to see if there were differences in mean social capital variables between urban and rural areas of each state, to account for possible differences between

urban and rural areas. No differences between the means of the variables to be analyzed were found, and thus, state data was used to represent MSA information. Also included in analysis was the question, “Immigrants are getting too demanding in their push for equal rights,” to which respondents could answer “Disagree strongly”, “Disagree somewhat”, “Neither/depends”, “Agree somewhat”, “Agree strongly”, “Don't know”, and “Refused” (2, 52).

The two other variables, faith-based social capital and racial trust, used in this analysis were calculated from variables already included in the dataset. Faith-based social capital and racial trust were already calculated in the 2000 dataset, whereas the 2006 dataset did not contain these variables pre-calculated (2, 52). Differences were found when comparing the means for the pre-calculated variables and the manually calculated variables for the 2000 dataset. However, differences were so small that the same formulas were used to compute the 2006 calculated variables. Mean values of respondents for both faith-based social capital and racial trust were calculated at the MSA level for both 2000 and 2006 data and were then used as rough measure for community-level opinion for faith-based social capital and racial trust.

Faith-based social capital was calculated by taking the average of the results of four variables: standardized church membership, standardized church service attendance, standardized non-religious service church participation, and standardized affiliation with non-church religious groups (2). Religious church membership asked “Are you a church member” (2, 52). Responses included “Yes” and “No”. Church attendance was assessed by asking, “Not including weddings and funerals, how often do you attend religious services?”, answers included, “None”, “Less than yearly”, “A few times a year”, “1 to 2

times per month", "Almost weekly", and "Weekly or more often" (2, 52). These answers were given numerical values of 0 for "None", 1 for "Less than yearly, 3 for "A few times per year", 18 for "1 to 2 times per month", 39 for "Almost weekly", and 52 for "Weekly or more often" (2, 52). Non-religious service church participation was assessed using the following question, "In the past 12 months, have you taken part in any sort of activity with people at your church or place of worship other than attending services" (2, 52). Answers to this question included, "No", "Yes", "Don't know", "Refused." Finally, affiliation with non-church religious groups was assessed by using the following question, "In the past 12 months, have you taken part in any sort of activity at your church or place of worship other than attending services" (2, 52). Answers included, "Yes", "No", "Don't know", and "Refused" (2, 52). Standardized variables were calculated by subtracting the standard deviation of the variable from each observation and then dividing by the mean value (2, 52).

$$Faithbase = \frac{Relmem + Relatte + Relpart + Grprel}{4}$$

$$Relmem = std.\ church\ membership$$

$$Relatte = std.church\ service\ attendance$$

Relpart= std. non-religious service church participation

Grprel=std. affiliation with non-church religious groups

Racial trust was calculated by taking the average of three racial trust scores. Respondents, except for their own race or ethnicity category, were asked, "How much do you trust Asians", "How much do you trust Blacks", "How much do you trust

Hispanics", "How much do you trust Whites"; responses included "Not at all", "A little", "Some", and "A lot" (2, 52).

$$Racetrst^{*} = \frac{trust\ Hispanics + trust\ Asians + trust\ Blacks + trust\ Whites}{3}$$

*excludes respondent's race

Online Tuberculosis Information System

The Online Tuberculosis System (OTIS) is a public-use dataset containing information about Tuberculosis (TB) cases occurring the in the United States and its territories since 1993 that is released by the Centers for Disease Control and Prevention (CDC) (3). TB is a required reportable disease, and thus every case of TB in the United States is reported to health officials by the Report of Verified Case of Tuberculosis (RVCT) (3). Usually, cases are first reported at the local or county level, and reports then are sent to state health departments which aggregate the data. The aggregated data is then sent to the CDC, where the data is totaled at the national level. To be a verified case, and thus included in the OTIS data set, a patient must be diagnosed with TB by one of the following hierarchical methods (3):

1. Positive culture
2. Positive nucleic acid amplification test
3. Positive acid-fast bacilli test
4. Clinical case confirmation
5. Provider diagnosis

All TB cases were included in this analysis regardless of verification criteria, site of disease, or multidrug resistant/extensively-drug resistant status.

In addition to case verification criteria information, the RVCT includes information associated with the development of TB disease, such as socio-demographic information (3). OTIS contains 27 variables which are a subset of variables recorded on the RVCT, with most the variables used in this analysis being 80% or more complete (3). Variables used in this in analysis include: Age Groups (<1 year, 1-5 years, 5-14 years and then every 10 years), MSA, Race/Ethnicity (American Indian/Alaskan Native, African American/Black Non-Hispanic, Asian/Pacific Islander, Hispanic, and White Non-Hispanic), Sex, and U.S-. or Foreign-born (3). MSAs were chosen if an MSA was represented in both OTIS, which only contains TB case information for the 100 most populated cities, and in either year of the *Social Capital Benchmark Survey* (3). Overall 25 unique MSAs were used, of which, 22 of 34 MSAs were included from the 2000 *Social Capital Benchmark Survey*, 3 MSAs of 11 MSAs were used from the 2006 *Social Capital Benchmark Survey*, and 3 MSAs used were included in both years of the *Social Capital Benchmark Survey* (2, 52). In total, 25 of 100 possible MSAs were included from the OTIS dataset (3).

Data was obtained by two, four-year groups, 1998-2002 and 2004-2008, to correspond to the 2000 and 2006 Social Capital Benchmark Survey years. Aggregation was performed in part to obtain enough cases for analysis with the 2000 and 2006 *Social Capital Community Benchmark Surveys*. Additionally, aggregation was done to limit data suppression, as OTIS suppresses cells of data with 5 or fewer cases due to confidentiality concerns. Because of suppression issues, variables were cross-tabulated in sets of three.

Cross-tabulated variables included MSA and two other demographic variables such as Age Groups and Sex.

Combining Social Capital and Online Tuberculosis Information System Data

Before both years of the *Social Capital Benchmark Survey* could be combined, normality for faith-based social capital, racial trust, and support of immigrants' rights was assessed, and all variables were found to be normally distributed. Means for variables to be analyzed in the 2000 and 2006 *Social Capital Benchmark Survey* were computed, by MSA, using Proc Surveymeans in SAS software system (Version 9.2, SAS Institute, Cary, NC). This was done to retain stratification and weighting induced by sampling methods. MSAs that were not contained in the OTIS database were removed. Finally, the 2000 and 2006 *Social Capital Benchmark Surveys* were concatenated by MSA.

For each of the OTIS tables, population information by MSA and the other two variables was added. For example, for the Age by Gender table, age and gender population estimates by MSA were added. The population estimates were obtained from the 2000 Census, published by the U.S. Census Bureau (44, 53-55). 2000 and 2006 OTIS tables with the same stratification, i.e. age by gender, were merged by MSA.

After obtaining the combined social capital dataset and all OTIS tables, the datasets were merged by year and MSA. Each demographic variable or demographic variable combination was individually merged with the combined social capital dataset. Four tables (Race and Sex, Age and Sex, U.S./Foreign-born and Race, and U.S./Foreign-born and Sex) containing Social Capital mean estimates, TB counts, and population estimates were produced.

Data Analysis

Exemption status was given by the Emory University Internal Review Board to access and use both the *Social Capital Community Benchmark Survey* and *Online Tuberculosis Information System* data (Appendix 1). Two stages of analyses were performed on the data, which included Descriptive Statistics and Poisson regression of compound symmetric correlated data. All analyses were done by using the SAS software system (Version 9.2, SAS Institute, Cary, NC).

Descriptive Statistics

Three descriptive statistics tables were created: means of exposure variables for survey participants in each MSA, a cross-tabulation of categorized exposure variables, and average TB case rates per 100,000 by exposure and demographic variables.

Mean exposure variable values by demographic variables were created using the 2000 and 2006 *Social Capital Community Benchmark Survey*. This descriptive analysis was not related to TB data and was done to describe the *Social Capital Benchmark Survey* respondents only. Age and race categories were created to reflect categorization used in the *Online Tuberculosis Information System* (OTIS) dataset from age and race information included in the *Social Capital Community Benchmark Survey.* Means and standard errors were calculated using sample weights with SAS. Missing values were due to individuals in certain demographic categories not responding to questions in either version of the *Social Capital Community Benchmark Survey*.

Tables showing the cross-tabulation of categorized exposure variables (MSA-mean faith-based social capital, MSA-mean racial trust, and MSA-mean support of

immigrants' rights) and the Metropolitan Statistical Areas (MSA) falling within each category were produced. Exposure variables were categorized into High, Medium and Low divisions based on distribution. This was done after taking the mean of each exposure variable, by MSA and keeping the weighting and stratification used in the *Social Capital Community Benchmark Survey*.

Finally, a table showing average, aggregated TB rates by categorized exposure variables and demographic variables was made. TB rates were calculated by dividing the number of aggregated TB cases by 2000 Census Bureau population estimates that were multiplied by the number of aggregation years. Again, TB cases were aggregated for the years 1998 to 2002 and 2004 to 2008. Thus, for all demographic data, except the year category, the denominator data was multiplied by 10. Exposure variables were divided into 3 categories, High, Medium and Low, based on distribution after taking the mean of each variable, by MSA, accounting for weighting and stratification. Case rates were defined as 0 for cells containing suppressed data.

Poisson Regression of Correlated Data

Poisson regression analysis using GEE models with compound symmetric correlation was performed to examine the association of faith-based social capital, racial trust, and support of immigrants' rights within each MSA on TB case rates (outcome) using SAS software system, version 9.2 (SAS Institute). Variables included in this analysis were age, race, gender, U.S. or Foreign-born status, year, Metropolitan Statistical Area (MSA), MSA-mean faith-based social capital, MSA-mean racial trust, and the MSA-mean of support of immigrants' rights. Again, 8 separate models containing a

single demographic variable, or a combination of demographic variables, were used due to TB case suppression. The variables for MSA-mean faith-based social capital, MSA-mean racial trust, and MSA-mean support of immigrants' rights were assessed for collinearity, and no collinearity issues were found. Dummy variables were used for the age, race, gender, U.S./Foreign-born status, and year. Age was divided into the following categories: "less than 1 year old", "1-4 years", "5-14 years", "15-24 years", "25-34 years", "35-44 years", "45-54 years", "55-64 years", "65-74 years", "75-84 years", "85 plus years old". The reference group was the "25-34 years" age group. Race was divided into the following categories: "American Indian or Alaskan Native, Non-Hispanic", "Asian or Pacifica Islander, Non-Hispanic", "Black or African American, Non-Hispanic", "Hispanic or Latino", and "White, Non-Hispanic" which served as the referent group. The gender variable consisted of two categories, "Male" and "Female", where the "Female" category served as the referent group. The U.S. and Foreign Born variable was also coded for by a dummy variable, with the "U.S.-born" category being the referent group. Finally, year was coded as a dummy variable and "2000" was defined as the referent group. Exposure variables for this analysis included MSA-mean racial trust, MSA-mean social capital, and MSA-mean support of immigrants' rights. Exposure variables were calculated taking the mean of the variable, by MSA, while keeping weight and stratification. Thus, each MSA had a single value for each variable.

Forward elimination was used for this analysis of Poisson regression of correlated data, thus the starting model included year and one demographic variable, either age, race, gender, or U.S./Foreign-born status. An example model is shown below:

$$\ln \lambda = \beta_0 + \beta_1 \text{Gender}$$

More complex models were created that included both age and race variables, age and sex variables, sex and race variables, U.S./Foreign-born status and race, U.S./Foreign-born and sex. Next, one exposure variable, either MSA-mean faith-based social capital, MSA-mean racial trust, or MSA-mean support of immigrants' rights were added to the model. All exposure variables were continuous.

$$\ln \lambda = \beta_0 + \beta_1 \text{Gender} + \beta_2 \text{MSA} - \text{mean faith} - \text{based social capital}$$

For models testing MSA-mean racial trust, four variables controlling for the proportion of Asians, Black, Hispanics, and Whites in each MSA, were added to the models. This was done as racial trust appeared to be affected by proportions of various races in each MSA, inducing statistically significant association between racial trust and TB rates. Proportions of Asians, Blacks, Hispanics, and Whites for each MSA were included in the 2000 *Social Capital Community Benchmark Survey*. For 2006 data, 2000 U.S. Census data was used to calculate race proportions for each MSA by taking the number of individuals in each race category and dividing by the total population. For MSAs that appeared in both datasets, 2000 *Social Capital Community Benchmark Survey* race proportions were used.

Next interaction was assessed by introducing interaction terms into models with exposure variables that had a p-value of 0.1 or lower. Exposure variables were considered significant at this level to highlight variables that may be important in future studies. Future studies may want to consider assessing these variables as possible risk factors for TB. Interaction terms were formulated by multiplying the demographic variables from each model by one exposure variable. All exposure variables were tested for interaction,

whether found to be significant in their own model or not. Interaction terms were tested for significance using the Likelihood Ratio Test for interaction, using a p-value of 0.05 or less for significance, as is convention. Thus, all final models adjusted for year, included either one or two demographic variables, one exposure variable, and significant interaction terms. In addition, race proportions were added to the model when adding the racial trust variable to the model. Models containing multiple exposure variables and/or multiple demographic variables were not created due to the limited number of TB cases by each MSA.

Results

Descriptive Statistics

Of the 22,217 participants in the Metropolitan Statistical Areas (MSAs) used in the 2000 and 2006 *Social Capital Community Benchmark Survey*, average faith-based social capital for African-Americans living in selected MSAs was 0.13 (S.E. 0.01). Faith-based social capital ranged from -1.11 to 1.56 and a mean value of -0.03, with higher values indicating higher levels of faith-based social capital. African Americans had the highest average faith-based social capital, compared to all other races including American Indian/Alaskan Native (-0.18, S.E. 0.06), Hispanic (-0.15, S.E. 0.01), and White (-0.04, S.E. 0.01) groups, while Asian/Pacific Islanders (-0.28, S.E. 0.04) had the lowest MSA-mean faith-based social capital. Faith-based social capital appeared to increase with age, as those 18-24 years old reported the least amount of social capital (-0.19, S.E. 0.02) while those 85 and older had the highest average of faith-based social capital (0.17, S.E. 0.05). Mean faith-based social capital differences were seen between the sexes, as men reported lower faith-based social capital overall (-0.11, S.E. 0.01), compared to women (0.03, S.E. 0.01). The years 2000 and 2006 differed by mean faith-based social capital, with 2006 respondents reporting higher faith-based social capital (-0.06, S.E. 0.01 versus 0.06, S.E. 0.02; Table 1).

Mean racial trust also varied by race for those living in selected MSAs, with Whites having the least mean racial trust compared to other races (2.13, S.E. 0.01), while Hispanics had the highest racial trust compared to other racial groups (1.62, S.E. 0.02). However, no American Indians/ Alaskan Natives responded to this question. Again, a

trend was observed for age categories, with mean racial trust decreasing as age increased. Gender differences were observed, with females (2.04, S.E. 0.01) reporting less racial trust than males (1.97, S.E. 0.01). Finally, racial trust appeared to increase slightly between 2000 (2.02, S.E. 0.01) and 2006 (1.96, S.E. 0.01; Table 1).

Finally, mean support of immigrants' rights for selected MSAs were calculated, and Whites reported on average higher positive views than other races (2.67, S.E. 0.01). Whereas Asian/Pacific Islanders reported, on average, were less supportive of immigrants' rights (3.17, S.E. 0.07), compared to other races. Negative views of immigrants appeared to increase with age. Males (2.75, S.E. 0.17) reported on average less support towards immigrants than females (2.68, S.E. 0.01). Finally, respondents reported more negative views of immigrants on average in 2006 (3.04 S.E. 0.03) compared to 2000 (2.62, S.E. 0.01; Table 1).

Cross-tabulations of categorized exposure variables and MSAs were performed to further check for collinearity. Tables 2a and 2b reported almost half of all MSAs within matching cells, which indicated collinearity between the variables. However, a majority of MSAs did not fall within these categories for these tables, demonstrating that collinearity was not a concern (Tables 2a and 2b). This was not observed for Table 2c, as majority of MSAs fell on the off-diagonal. Thus, 6 MSAs reported low MSA-mean immigrants' rights views and high racial trust, while another 6 MSAs reported high MSA-mean immigrants' rights views and low racial trust (Table 2c). MSAs within other combinations were observed as well (Table 2c).

Rates of tuberculosis (TB) were calculated by using demographic information and categorized exposure information. Again, TB cases were included if cases resided in MSAs selected for analysis. Overall, males (5.01 cases per 100,000) had higher average rates of TB compared to females (2.74 cases per 100,000). Males also had higher average rates of TB for all categories of exposure variables. TB rates for males residing in MSA's categorized by MSA-mean faith-based social capital were highest in the medium category (5.36 cases per 100,000), while the high faith-based social capital category had the lowest TB rates for males (4.52 cases per 100,000). This result was similar for females. Average TB rates for racial trust were highest for the MSA's in the medium category for both males (5.84 cases per 100,000) and females (3.19 cases per 100,000). Lowest average TB rates were seen in the MSAs in the low racial trust category for both sexes. Highest average TB rates were reported by MSAs in the low category for support of immigrants' right for both males (6.86 cases per 100,000) and females (3.55 cases per 100,000). The lowest average TB rates were reported by MSAs in the medium immigrants' rights views categories for both males (3.67 cases per 100,000) and females (2.13 cases per 100,000; Table 3).

TB rates in selected MSAs differed by year, as a higher TB rate was seen in 2006 with 8.1 cases per 100,000, while in 2000 there were 7.80 cases per 100,000. In 2000, the highest average TB rates were reported by MSAs in the high faith-based social capital category (8.42 cases per 100,000), while in 2006 the highest average TB rates were reported by MSAs in the medium faith-based social capital category (10.93 cases per 100,000). Lowest average TB rates were reported by MSAs in the medium faith-based social capital category for 2000 (7.13 cases per 100,000), while the lowest average TB

rates were reported by MSAs in the low faith-based social capital category for 2006 (0 cases per 100,000). In 2000, the highest average TB rates were reported by MSAs in the high racial trust category (9.34 cases per 100,000), while the lowest average TB rates were reported by MSAs in the low racial trust category (5.47 per 100,000). In 2006, the highest average TB rates were reported by MSAs in the medium racial trust category with 12.85 cases per 100,000, while the lowest average TB rates were reported by MSAs in the low racial trust category (2.95 per 100,000). Finally, for both years, MSAs that fell into the low category for MSA-mean support of immigrants' rights had the highest average TB case rates (11.85 cases per 100,000 and 8.76 cases per 100,000). While in 2000, the lowest average TB case rate was seen in MSAs within the medium immigrants' rights views category (6.12 cases per 100,000), and in 2006 the lowest average TB case rate was reported by MSAs in the high immigrants' rights views category (0 cases per 100,000; Table 3).

Foreign-born individuals living in selected MSAs had higher average TB rates per 100,000 compared to U.S.-born individuals, with an average case rate of 2.19 per 100,000 compared to 0.29 per 100,000. U.S.-born individual's average case rates were highest for MSAs that were included in the medium faith-based social capital category (0.35 cases per 100,000) and lowest MSAs included in the low faith-based social capital category (0.22 cases per 100,000). For Foreign-born individuals, the highest average TB case rates were seen in MSAs that were in the low faith-based social capital category (2.52 cases per 100,000) and MSAs that were in the lowest in the medium faith-based social capital category (2.03 cases per 100,000). MSAs within the high racial trust category contained the highest average TB case rates for U.S.-born individuals (0.39

cases per 100,000), while highest average TB case rates were observed for MSAs in the low racial trust category for Foreign-born individuals (2.66 cases per 100,000). The lowest average case rates were observed in MSAs within the low racial trust category for U.S.-born individuals (0.16 cases per 100,000) and lowest for the MSAs within the high category for Foreign-born individuals (1.92 cases per 100,000). Finally, for both U.S.-born and Foreign-born individuals, the highest average TB case rates were observed for MSAs which, on average, had low support of immigrants' rights category (0.38 cases per 100,000 and 22.57 cases per 100,000). While for U.S.-born individuals, the lowest average TB case rates were seen in MSAs within the high support of immigrants' rights category (0.22 cases per 100,000) and for Foreign-born individuals the lowest average TB case rates were seen in MSAs within the medium immigrant's rights views categories (1.94 cases per 100,000; Table 3).

Whites living in selected MSAs were found to have the highest average TB case rates in this study, with 1.15 cases per 100,000. American Indian/Alaskan Natives were found to have the lowest TB case rates with 0.01 cases per 100,000. Lowest average TB case rates were observed for the medium category of faith-based social capital for American Indians/Alaskan Natives (0.00 cases per 100,000), and the high category for Asian/Pacific Islanders (0.13 cases per 100,000), and Hispanics (0.09 cases per 100,000). The lowest average TB case rates were seen in the low category of faith-based social capital for African Americans (0.86 cases per 100,000), and the medium category for faith-based social capital for Whites (0.93 cases per 100,000). Highest average TB case rates were observed for MSAs within the low faith-based social capital categories for American Indian/Alaskan Natives (0.03 cases per 100,000), Asian/Pacific Islanders (1.47

cases per 100,000), and Hispanics (1.27 cases per 100,000), while both African American (1.44 cases per 100,000) and Whites (1.61 cases per 100,000) had the highest average TB case rates in MSAs that reported high faith-based social capital category. Asian/Pacific Islanders (0.44 cases per 100,000), African Americans (0.65 cases per 100,000), and Hispanics (0.10 cases per 100,000) all had the lowest average TB case rates for MSAs within the low racial trust category, while American Indians/Alaskan Natives (0 cases per 100,000) had the lowest average TB case rates for MSAs in the medium racial trust category, and Whites had the lowest average TB case rates in the high racial trust category (0.96 cases per 100,000). Again, Asian/Pacific Islanders (0.99 cases per 100,000), and African Americans (1.46 cases per 100,000) had the highest average TB case rates in the MSAs within the medium racial trust category. Hispanics (1.10 cases per 100,000) had the highest average case rates in MSAs within the highest racial trust category, and Whites had the highest average TB case rates in MSAs within the low racial trust category (1.28 cases per 100,000). American Indian/Alaskan Natives had the same rate for both MSAs in the low and high racial trust categories (0.01 cases per 100,000). Finally, the lowest observed average TB rates for all races were seen in MSAs within the medium immigrants' rights views category. For Asian/Pacific Islanders (0.97 cases per 100,000), African Americans (1.17 cases per 100,000), and Whites (1.23 cases per 100,000), the highest average TB case rates were seen within MSAs in the high support of immigrants' rights category. For Hispanics the highest average TB case rates were seen in MSAs in the low support of immigrants' rights category (0.25 cases per 100,000). American Indian/Alaskan Natives again had the same case rate for MSAs in

both the low and high support of immigrants' rights categories (0.01 cases per 100,000; Table 3).

Average TB rates were observed to increase with age for those living in selected MSAs, and those 85 years and older had the highest TB rates of 9.39 per 100,000. Those less than 1 year to 34 years old had the highest TB rates in MSAs within the low categorization of faith-based social capital. However, for those 35 to 64 years old, the highest average TB rates were seen in MSAs that were in the medium faith-based social capital category. For those 75 years and older, highest average TB rates were seen in MSAs that reported high faith-based social capital categorization. The lowest average TB rates were seen in MSAs with the high faith-based social capital for those less than one year old to 64 years old. For those 65 to 74 years old, the lowest average TB rates were reported in MSAs within the medium faith-based social capital division. Finally, for those 85 years and older, the lowest average TB rates were seen in MSAs in the low faith-based social capital category (7.73 cases per 100,000). For all ages, the lowest average TB rates were observed in MSAs in the low racial trust category. For those less than 1 to 14 years old, highest average TB case rates were seen in MSAs within the medium racial trust category. For those 15 to 84 years old, the highest TB case rates were seen within MSAs in the high racial trust category. The highest average TB case rates were seen in MSAs in the medium faith-based social capital category for those 85 years and older (10.81 cases per 100,000). Finally, the lowest average TB case rates were seen within MSAs in medium support of immigrants' rights category for those who were less than one year old to 34 years old. For those 35-54 years old, the lowest average TB case rates were seen in MSAs within the high support of immigrants' rights category.

Similarly to those less than 1 to 34 years old, the lowest average TB case rates were seen in those 55 years old and older and living in MSAs that reported having medium support of immigrants' rights. For those less than one, highest average TB case rates were seen for MSAs that had high support of immigrants' rights (3.26 cases per 100,000), and for all other age categories the highest average TB case rates were seen for MSAs in the low support of immigrants' rights category (Table 3).

Poisson Analysis of Correlated Data

First a model was created to examine the association between sex and year. In a model that controlled for year and sex, Males, living in selected MSAs, were at greater risk for TB infection compared to females (RR: 1.61, 95% CI: 1.49, 1.73). In addition, MSAs in 2006 were more likely to be diagnosed with TB than MSAs selected in 2000, but this result was not statistically significant (RR: 1.20, 95%CI: 0.92-1.56; Table 4). A similar association was seen in subsequent models, except for two, regardless of demographic variables. Next, MSA-level faith-based social capital was added to the original model. A 1-standard deviation increase in faith-based social capital was associated with a 0.71 decreased rate of active TB in selected MSAs after adjusting for sex and year (95% CI: 0.30-1.71). In addition after adding racial trust to the original model, decreased TB risk was associated with MSAs that had lower amounts of racial trust than MSAs that had greater racial trust, after adjusting for racial composition within each MSA, year and sex (RR: 0.35, 95% CI: 0.04-3.19). In a model containing year, sex, and MSA-mean support of immigrants' rights, MSAs with less support of immigrants' rights were more likely to have increased risk for TB than MSAs reporting more support of immigrants' rights when adjusting for year and sex (RR:2.21, 95% CI: 1.14-4.28;

Table 5). A sex and support of immigrants' rights interaction term was also added to this model.

Age was also found to be associated with TB rates, in a model that contained age and year. The risk for developing TB increased with age, as those less than one year old, in selected MSAs, had a risk ratio of 0.13 (95% CI: 0.04-0.47) compared to the referent group of 25-34 year older. Those 85 years and older, living in selected MSAs, had a risk ratio of 2.09, compared to the referent group of 25-34 years old (95% CI: 1.68-2.61). Next, each exposure variable was added independently to the original model. MSAs with higher levels of faith-based social capital had decreased risk for TB when compared to MSAs with lower levels of faith-based social capital when adjusting for age and year (RR: 0.68, 95% CI: 0.28-1.64). Decreased risk for TB was seen in MSAs that had lower levels of racial trust compared to MSAs with higher levels of racial trust, when adjusting for racial composition within selected MSAs, year and age (RR: 0.31, 95% CI: 0.03-2.81). In addition, MSAs that on average had less support of immigrants' rights were more likely to have an increased risk for TB when compared to MSAs who on average had more supportive views, when adjusting for year and age (RR:1.50 times, 95% CI: 0.86-2.63; Table 5).

Next, race was examined to see its association with exposure variables and risk for TB. Only American Indians/ Alaskan Natives residing in selected MSAs were found to have lower TB risk than Whites, who served as a referent group (RR: 0.02, 95% CI: 0.01-0.06). Hispanics living in selected MSAs were found to have the highest risk ratio of 1.73 when compared to Whites (95% CI: 1.11-2.70). Asians and African Americans/Blacks living in selected MSAs had risk ratios of 1.60 (95% CI: 0.96-2.67)

and 1.61 (95% CI: 1.22-2.13), respectively when compared to Whites. A decreased risk for TB was associated with MSAs that had higher faith-based social capital when compared to MSAs with low faith-based social capital, after controlling for year and race (RR: 0.53, 95% CI: 0.20-1.42). In addition, a 1-standard deviation increase in racial trust was associated 0.92 decrease in TB rates in selected MSAs when added to the original model and adjusting for racial composition (95% CI: 0.14-6.08). Finally, MSAs that had less supportive views on immigrants' rights, when added to the original model, were more likely to see increased risk for TB when compared to MSAs that expressed less supportive views of immigrants' rights (RR:1.39, 95% CI: 0.0.85-2.28; Table 5).

A model was run to examine U.S.-born and Foreign-born population differences. Those living in selected MSAs and born outside of the United States were found to be 6.35 times more likely to be diagnosed with TB than those born within the United States and living in selected MSAS when adjusting for year and U.S./Foreign-born status (95% CI: 4.65-8.67; Table 4). Next, exposure variables were individually added to the original model, which contained year and U.S./Foreign-born variables. MSAs reporting higher faith-based social capital were more likely to have more TB cases than MSAs with low levels of social capital when adjusting for year and U.S./Foreign-born status (RR: 2.01, 95% CI: 0.97-4.16). In addition, decreased risk for TB was seen in MSAs that had less racial trust, when compared to MSAs with more racial trust after adjusting for year , racial composition, and U.S./Foreign-born status (RR: 0.55, 95% CI: 0.09-3.51). MSAs with less support of immigrant's rights were more likely to have increased risk for TB when compared MSAs with more positive immigrants' rights views when adjusting for year and U.S./Foreign-born status (RR: 1.20, 95% CI: 0.90-1.61; Table 5).

Race and sex were both adjusted for in a model, to further the examination between race, sex, exposure variables, and TB risk. Additionally, males living in selected MSAs were found to be 1.61 times more likely to be diagnosed with TB when compared to females when adjusting for year (95% CI: 1.49-1.74). Asian/Pacific Islanders living in selected MSAs were 17.32 times more likely to develop TB when compared to Whites when controlling for year, race and sex (95% CI: 14.01-21.39). African American/Blacks living in selected MSAs had the next highest risk, with African American/Blacks being 8.29 times more likely to be diagnosed with TB when compared to Whites when controlling for year, race and sex (95% CI: 6.58-10.45). Hispanics living in selected MSAs were 6.22 times more likely to be diagnosed with TB when compared to Whites when controlling for year, race and sex (95% CI: 4.77-8.11). Only American Indian/Alaskan Natives living in selected MSAs were less likely to develop TB when compared to Whites when controlling for year and sex (RR: 0.62, 95% CI: 0.57-0.67; Table 4). Again, exposure variables were added separately into the original model. MSAs that had higher amounts of social capital were more likely to have increased risk for TB when compared to MSAs that had lower amounts of social capital after controlling for year, race and sex (RR: 1.54, 95% CI: 1.04-2.29). In addition, MSAs with less racial trust were at decreased risk for TB compared to MSAs with more racial trust, when adjusting for racial composition in each MSA, year, race and sex (RR:0.94, 95% CI:0.14-6.19). Finally, increased risk for TB was observed in MSAs which had less support of immigrants' rights when compared to MSAs with more support, after adjusting for year, race and sex (RR: 1.20, 95% CI:0.90-1.61; Table 5).

Next, a model to examine the effects of age, sex and exposure variables on TB rates was created. Similarly to the sex alone model, males living in selected MSAs were 1.70 times more likely to be diagnosed with TB than females when controlling for year and age (95% CI: 1.59-1.81). Again, those living in selected MSAs and in young age categories were less likely to develop TB when compared to the 25-34 year olds referent group when controlling for year and sex. For example, those less than one year old and living in selected MSAs were 0.06 times less likely to develop TB than those in the 25-34 year old reference group when controlling for year and sex (95% CI: 0.01-0.23). Those in the 45-54 year old group and living in selected MSAs were 1.16 times more likely to develop TB than those in the 25-34 year old referent group when controlling for year and sex (95% CI: 1.06-1.27). This increased risk was seen for all other age categories older than the 45-54 year old group when controlling for year and sex (Table 4). Next, exposure variables were added separately to this model. MSAs reporting more faith-based social capital were more likely to have decreased risk for TB than MSAs who had less faith-based social capital when controlling for year, sex, and age (RR: 0.68, 95%CI: 0.28-1.65). Less racial trust in MSAs was associated with decreased risk for TB when compared to MSAs with more racial trust after adjusting for year, racial composition, age and sex (RR:0.35, 95% CI: 0.04-3.28). Finally, MSAs with less supportive views on immigrants' rights were more likely to have increased TB risk when compared to MSAs that had more supportive attitudes and adjusted for year, age and sex (RR: 1.91, 95% CI:0.96-3.79; Table 5).

A model containing U.S.-born and Foreign-born status, race, and exposure variables was created. All races living in selected MSAs were associated with increased

TB rates when compared to Whites. African American/Blacks had the highest risk ratio of 8.75 (95% CI: 6.99 to 10.94), Asian Pacific Islanders had the next highest risk ratio with 5.60 (95% CI: 4.93-6.35), then American Indian/Alaskan Natives with a risk ratio of 3.27 (95% CI: 1.47-7.29) when compared to Whites and controlling for year and U.S./Foreign-born status. Finally, Hispanics had the lowest risk ratio of 2.71 when using Whites as a referent group when controlling for year and U.S./Foreign-born status (95% CI: 2.13-3.45). Foreign-born individuals, living in selected MSAs, were 4.74 times more likely to be diagnosed with TB when compared to U.S.-born individuals and controlling for year and race (95% CI: 3.52-6.37; Table 4). Also, exposure variables were added individually to the original model. MSAs with more faith-based social capital had increased TB rates when compared to MSAs that had less faith-based social capital and when controlling for year, U.S./Foreign-born status, and race (RR:1.63, 95% CI:1.12-2.39). Less racial trust was associated with decreased risk for TB compared to MSAs with more racial trust and after controlling for year, U.S./Foreign-born status, and racial composition (RR:0.85, 95% CI: 0.15-4.69). Finally, MSAs that had less support for immigrants' rights were more likely to develop TB, compared to MSAs that had more supportive views of immigrants' rights after controlling for year, U.S./Foreign-born status, and race (RR:1.17, 95% CI:0.85-1.61;Table 5).

A U.S./Foreign-Born and sex model was created to examine the effects of these variables and exposure variables on TB rates. Both males (RR: 1.60, 95% CI: 1.50-1.72) and Foreign-born individuals (RR: 6.26, 95% CI: 4.57-8.58) living in selected MSAs were more likely to be diagnosed with TB, when compared to females and U.S.-born individuals when controlling for year and either sex or U.S./Foreign-born (Table 4).

Additionally, exposure variables were added separately into the original model. MSAs that had more faith-based social capital were more likely to have increased risk for TB when compared to MSAs with lower faith-based social capital when adjusting for year, U.S./Foreign-born status, and sex (RR:3.81, 95% CI: 1.34-10.85). The interaction term between sex and faith-based social capital was found to be significant in this model. MSAs with decreased racial trust were associated with decreased TB risk when compared to MSAs that had more racial trust, after adjusting for year, racial composition, U.S./Foreign-born status, and sex (RR: 0.54, 95% CI: 0.09-3.38). Finally, decreased support of immigrants' rights was associated with increased risk for TB in MSAs when compared to MSAs that had increased support of immigrants' rights when adjusting for year, U.S./Foreign-born status, and sex (RR: 1.14, 95% CI: 0.80-1.64; Table 5).

Two models were created that examined the association between exposure variables and the Foreign-born population's TB case rates. The first model contained sex and year demographic variables. Different from all previous models, Foreign-born individuals living in selected MSAs in 2006 were 0.79 less likely to develop TB compared to those living in selected MSAs in 2000 (95%CI: 0.64-0.97). Foreign-born males living in selected MSAs were 1.44 times more likely to develop TB when compared to Foreign-born females (95%CI: 1.35-1.54; Table 4). Next, exposure variables were added separately to the previously mentioned model. MSAs that reported higher faith-based social capital were at a 0.86 decreased risk for TB among Foreign-born individuals when compared to MSAs with low faith-based social capital (95%CI: 0.68 1.62). Foreign-born individuals living in selected MSAs that reported decreased racial trust were at an increased risk for TB, when compared to MSAs that reported increased

racial trust when adjusting for racial composition (RR: 1.16, 95%CI: 0.08-17.68). Finally, increased support of immigrants' rights in MSAs was associated with decreased TB rates amongst foreign-born individuals when compared to MSAs that reported decreased support of immigrants' rights (RR: 0.85, 95%CI: 0.62-1.15; Table 5).

Finally, a race model, which included race and year, was examined for Foreign-born individuals living in selected MSAs. Again, a decreased risk for TB was observed in Foreign-born individuals living in selected MSAs in 2006 when compared to Foreign-born individuals living in selected MSAs in 2000 (RR: 0.78, 95%CI: .0.64-0.95). For Foreign-born individuals living in selected MSAs when compared to Foreign-born Whites, American Indian/Alaskan Natives were 0.30 times less likely to develop TB (95%CI: 0.04-2.18), Asian/Pacific Islanders were 5.55 times more likely to develop TB (95%CI: 4.73-6.50), African American/Blacks were 9.10 times more likely to develop TB (95%CI: 5.24-15.81), and Hispanics were 2.39 times more likely to develop TB (95%CI: 1.88-3.03; Table 4). Next, exposure variables were added individually to the original model. Foreign-born individuals were at an increased risk for TB if they resided in MSAs with high levels of faith-based social capital (RR: 1.35, 95%CI: 0.60-3.03). Foreign-born individuals living in MSAs with high racial trust were at a decreased risk for TB when compared to Foreign-born individuals living in MSAs with low racial trust and when adjusting for racial composition (RR: 0.64, 95%CI: 0.07-5.75). Finally, Foreign-born individuals were at a decreased risk for TB if they lived in MSAs with more support of immigrants' rights when compared to MSAs with less support of immigrants' rights (RR: 1.09, 95%CI: 0.76-1.56; Table 5).

Discussion

Summary of Findings

All exposure variables' means appeared to differ by age, race, sex, and year for respondents of the *Social Capital Community Benchmark Survey*; however, these results were not tested for significance (Table 1). Cross-tabulations of categorized exposure variables and metropolitan statistical areas (MSAs) were performed to further check for collinearity. For MSA mean faith-based social capital by MSA-mean racial trust, and MSA-mean faith-based social capital by MSA-mean support of Immigrants' rights (Tables 2a and 2b), about half of the MSAs fell within a similar category for both exposure variables, suggesting moderately high correlation. For Table 2c, there is less evidence for collinearity between MSA-Mean Racial Trust, and MSA-Mean Support of Immigrant's rights. Tuberculosis (TB) rates also differed by age, race/ethnicity, gender, U.S./Foreign-born status, and year (Table 3).

MSA-level faith-based social capital appeared to be significant, using a p-value of 0.10 or less, for three models: the race and sex model, the U.S./Foreign-born and Race model, and the U.S./Foreign-born and Sex model. For all of these models, increasing MSA-level faith-based social capital was associated with increased TB case rates (Table 5). MSA-level racial trust was not significantly associated with TB case rates in any of the models adjusting for MSA racial composition (Table 5). In two models, being less supportive of immigrants' rights was found to be significantly associated with increased TB rates, when considering a p-value of 0.10 or less (Table 5). No interaction terms for U.S./Foreign-born and exposure variables were found to be significant. Finally, MSA-

mean faith-based social capital, MSA-mean racial trust, and MSA-mean support of immigrants' rights were not significantly associated with TB case rates for the Foreign-born population alone (Table 5).

Comparison to Literature

Every year the CDC's Division of Tuberculosis Elimination produces their annual *Reported Tuberculosis in the United States*, which contains an accurate representation of tuberculosis (TB) cases reported to the CDC each year (4). TB case rates in this study are different when compared to case rates presented in the *Reported Tuberculosis in the United States* due to a limited number of Metropolitan Statistical Areas (MSAs) being used and the TB case data being aggregated to eliminate suppressed results (Table 3). However, overall trends are similar to actual results, except for race/ethnicity rates and year (Table 3). Averaged TB case rates between 2000 and 2006 as reported by *Reported Tuberculosis in the United States* are as follows: American Indian/Alaskan Natives had 8.7 cases per 100,000, Asian/Pacific Islanders had 23.56 cases per 100,000, African-Americans had 12.23 cases per 100,000, Hispanics had 10.14 cases per 100,000, and Whites had 1.47 cases per 100,000 (4). Again, this is probably due to the MSAs used in the analysis, as they likely have proportions of races that are different than seen at the national level.

As stated previously, only one study, by Holtgrave and Crosby, has examined the association between social capital and TB (1). Holtgrave and Crosby found that higher social capital was associated with decreased TB rates in models including income inequality and poverty measures (1). The social capital measure used in the present study

was religious based, instead of focused on participation in general community activities, and partially explains the contradictory results. This difference may especially hold true for the U.S./Foreign-born models, as Foreign-born individuals usually attend religious services with other Foreign-born individuals (56). This lack of diversity could cause an increased exposure to those with TB. A similar association was found in the race and sex model and could likely be explained for similar reasons. Studies have found that religious organizations tend to attract individuals of similar backgrounds (57). Consequently, an individual may have greater exposure to TB at their religious organization than when interacting in the general population, especially if they are a member of a racial or ethnic minority.

In addition, only interacting with those of similar background may decrease the availability of resources one could obtain through interacting with individuals of varied backgrounds. Diverse social networks may allow for a more rapid spread of knowledge about health, as individuals share information amongst themselves and to communities which they belong (48). Kawachi and Berkman proposed this mechanism as possible reason for the inverse association between social capital and health outcomes (48). Decreased trust in others outside of one's community may also play a role, as decreased trust may cause apprehension when adding individuals to one's social network. Again, this is a proposed mechanism of social capital's influence on health by (48). In areas with negative views of immigrants, Foreign-born individuals may express more distrust of those outside of their community because of greater awareness of the outside community's negative outlook. Previous negative experiences by individuals themselves, or by individuals within the community, may further cause this distrust to evolve. These

associations might possibly be seen more in the immigrant community, especially in areas that are not supportive of immigrants. Similarly, accumulating a diverse social network could be harder for immigrants and immigrant communities due to language issues and accessibility.

In addition to the associations found between faith-based social capital and TB rates, a relationship between support of immigrants' rights and TB rates was also found in the sex alone model and age and sex model. Aversion to immigrants' rights is often a politically conservative view point, and increased political conservatism in certain MSAs may allow for conservative politicians to be elected. Politicians in turn may pass spending cuts on public health programs, which have previously been associated with TB resurgences. For example, the TB resurgence during the Reagan administration was due to public health cuts in addition to the emergence of the HIV/AIDs epidemic (58). Also, conservative MSAs may pass more anti-immigrant legislation than in other more central or left leaning MSAs. These anti-immigrant laws could limit Foreign-born individuals' access to a variety of services, affecting immigrants' SES status, occupation, living conditions, health services and more, which may lead to increased TB rates amongst Foreign-born individuals.

Strengths and Limitations

Strengths of this study included examining the association between social capital and TB rates at the MSA level, examining the association between social capital, immigrants and TB rates, and having a study population representative at the national level. Examining the effect of social capital on TB rates has not previously been

performed at the MSA level. Social interaction between individuals is often better understood at smaller levels, as individuals tend to obtain a majority of their social capital at smaller, more community based levels, not country, state or even MSA levels. While examining the effect of faith-based social capital at the individual or community level was not feasible, due to data restrictions, this study allowed for more insight than Holtgrave and Cosby's study analyzed at the state level (1). A second strength of this study includes examining social capital among immigrants. This aspect is very important as immigrants represent the majority of TB cases in the United States, and gaining insight into risk factors associated with the Foreign-born population is necessary to reduce TB rates in the United States. Finally, this study examined MSAs from all regions of the U.S, and thus the study is fairly representative of the United States population as a whole.

As previously stated, findings of this study would be stronger if individual level TB data could be obtained. However, the data was not available due to confidentiality reasons. In addition, using faith-based social capital as an exposure variable, as opposed to generalized social capital, may also be a limitation to this study. The social capital that was captured in this study may be different than social capital captured in previous studies. This could be due to the fact that those who have high faith-based social capital may be different than those who have higher generalized social capital, as religious organizations may be less diverse than various community activities.

Public Health Implications

All models controlling for U.S./Foreign-born status and adding faith-based social capital as an exposure variable were found to be significantly associated with increased

TB rates. More studies must be done to further understand the differences found between TB rates for faith-based social capital and generalized social capital. Regardless of differences found between faith-based social capital and generalized social capital, studies examining the association between social capital and TB rates with individual level data should be conducted. These studies would give a more accurate depiction of the relationship between social capital and TB rates. Additional studies might examine the relationship between bridging and bonding social capital's association with the Foreign-born population's TB rates. Knowledge gained from these studies may help to guide future TB reduction initiatives and health policies in the future.

From these findings, interventions may be developed to help decrease barriers to healthcare. For example, if immigrants are found to receive most of their knowledge about TB, TB screenings, and TB treatment from those in their community, healthcare workers could work more directly within immigrant communities to increase healthcare promotion. Healthcare workers will likely need to gain the trust of those within the community first, as immigrants maybe distrustful due to immigration status concerns. Trust can be gained by working closely with the community. For instance, health authorities could meet with community leaders to discuss topics related to TB and emphasize impartiality. Community leaders may then inform their community about the importance of TB risk reduction, or encourage individuals to obtain medical care from public health authorities. Similar actions may be taken in U.S.-born, minority populations. It should be noted that, when possible, interventions should be customized to the specific community to ensure improved TB case rates.

In the future, interventions may also be designed to bring together U.S.-born and Foreign-born individuals. An example of such an intervention would be a multicultural day in an MSA to bring all communities within the MSA together. During this event individuals of various backgrounds could meet. Additionally, if negative views of immigrants are further found to be associated with worse health outcomes, United States citizens may be warned about the costs, both financially and socially, that these negative viewpoints are harming not only Foreign-born individuals, but U.S.-born individuals as well. This could be done by holding town-hall meetings and through media, including magazine, television, and newspaper articles.

Finally, this study adds more information to the growing number of studies looking at social determinants of health and disease in general. This study found an association between TB rates and faith-based social capital, but these results were opposite of what previous studies have found. This is important, though, as understanding which forms of social capital are associated with reducing disease burden will help guide future decisions regarding interventions and policies. Adding to this literature will also help give credence to the relationship between social determinants of health and disease and spur more action to be taken in regards to social determinants of health.

Future Directions

To eliminate tuberculosis in the United States, a better understanding of risk factors associated with reactivation and transmission of TB in the Foreign-born population must occur. These studies should use individual level TB data to further validate these findings or previous findings. Specifically, studies examining Foreign-born

populations and social capital should focus on where the Foreign-born population is receiving a majority of their social capital and social support. Future studies may show that certain types of social capital may be beneficial or detrimental to Foreign-born individuals' health. This awareness may help to create productive, effective interventions that will reduce TB risk in the Foreign-born population. Further, these findings may be applicable to other communicable diseases that disproportionally affect Foreign-born individuals and these relationships should be studied in the future.

As mentioned previously, targeted interventions may be created once an overall understanding of the association between TB and social capital is accomplished. These interventions will likely be more successful, as populations that will benefit the most will be targeted and inventions customized to ensure disease reduction. While this study identifies faith-based social capital as a possible risk factor for the development of TB, other studies may show that more generalized social capital is protective against the development of TB. After this relationship is further validated, intervention programs to reduce barriers to access of healthcare can be devised. Finally, other interventions and policies maybe created to enhance immigrants' experiences in the United States by offering them more services that will help them to adjust to life in the U.S.

Conclusion

To eliminate tuberculosis in the United States, steps need to be taken to reduce TB rates in the Foreign-born population. Certain risk factors for the Foreign-born population are well known, such as country of origin and living conditions. In addition, delays in seeking healthcare have also been examined in this population, and studies have

found that issues such as language barriers and immigration status concerns have been associated with delays in seeking healthcare. However, few studies have examined the relationship between social determinants of health and TB. The present study adds to the current literature examining the relationship between social determinants of health and TB rates. Both faith-based social capital and decreased support of immigrants' rights were found to be associated with an increased risk for the development of TB. Therefore, future studies should fully examine these relationships, so that effective interventions and policies can be made to reduce TB rates in the Foreign-born population. Hopefully in the future, these findings will prevent Foreign-born individuals from undergoing intensive and stressful TB treatment while learning to adjust to life in a new culture.

References

1. Holtgrave, DR, Crosby, RA. Social Determinants of Tuberculosis Case Rates in the United States. *Am J Prev Med*. 2004; 26(2): 159-162.

2. Roper Center for Opinion Research. *Social Capital Benchmark Survey, 2000*. Storrs, CT: University of Connecticut; 2001.

3. Centers for Disease Control and Prevention, US Department of Health and Human Services. Online Tuberculosis Information System. Atlanta, GA: Centers for Disease Control and Prevention; 2010. (http://wonder.cdc.gov/tb.html). (Accessed December 10, 2011).

4. Centers for Disease Control and Prevention. *Reported Tuberculosis in the United States*. Atlanta, GA: Centers for Disease Control and Prevention; 2010.

5. Nelson, KE, Williams, CM. *Infectious Disease Epidemiology: Theory and Practice*.2nd Ed. Sudbury, MA: Jones and Bartlett Publishers, Inc.; 2004.

6. Centers for Disease Control and Prevention. *Latent Tuberculosis Infection: A Guide for Primary Health Care Providers.* Atlanta, GA: Centers for Disease Control and Prevention; 2010.

7. Russel, DG. Who puts the tubercle in tuberculosis? *Nature Reviews Microbiology*. 2007; 5: 39-47.

8. Russel, DG, Barry, CE, Flynn, JL. Tuberculosis: What we don't know can, does , hurt us. *Science*. 2010; 328: 852-856.

9. Centers for Disease Control and Prevention. *Controlling tuberculosis in the United States: recommendations from the American Thoracic Society.* Atlanta, GA: Centers for Disease Control and Prevention; 2005. (MMWR, 54)

10. Berrington, WR, Hawn, TR. Mycobacterium tuberculosis, macrophages, and innate immune response: does common variation matter? *Immunol Rev*. 2007; 219: 167-186.

11. Borgdorff, MW, Behr, MA, Nagelkerke, JD, et al. Transmission of tuberculosis in San Francisco and its association with immigration and ethnicity. *Int J Tuberc Lung Dis*. 2000; 4(4): 287-294.

12. Schaaf, HS, Collins, A, Bekker, A, et al. Tuberculosis at extremes of age. *Respirology*. 2010; 15(5): 747-763.

13. Jiménez-Corona, ME, García- García, L, DeRiemer, K, et al. Gender differentials of pulmonary tuberculosis transmission and reactivation in an endemic area. *Thorax*. 2006; 61: 348-353.

14. Hudelson, P. Gender differentials in tuberculosis: the role of socio-economic and cultural factors. *Tubercle and Lung Disease.* 1996; 77:391-400.

15. Nava-Aguilera, E, Andersson, N, Mitchel, S, et al. Risk factors associated with recent transmission of tuberculosis: systematic review and meta-analysis. *Int J Tuberc Lung Dis*. 2009; 13(1): 17-26.

16. Dooley KE, Chaisson, RE. Tuberculosis and diabetes mellitus: convergence of two epidemics. *Lancet Infect Dis.* 2009; 9(12): 737-746.

17. Aaron, L, Saadoun, D, Calatroni, I, et al. Tuberculosis in HIV-infected patients: a comprehensive review. *Clin Microbiol Infect*. 2004; 10: 338-398.

18. Cook, RT. Alcohol Abuse, Alcoholism, and Damage to the Immune System-A Review. *Alcoholism: Clinical and Experimental Research*. 1998; 22(9): 1927-1942.

19. Hussein, MM, Mooij, JM, Roujouleh, H. Tuberculosis and chronic renal disease. *Seminars in Dialysis*. 2003; 16 (1): 38-44.

20. Lienhardt, C. From Exposure to Disease: The Role of Environmental Factors in Susceptibility to and Development of Tuberculosis. *Epidemiologic Reviews.* 2001; 23(2): 288-301.

21. Gao, L, Tao, Y, Zhang, L, et al. Vitamin D receptor genetic polymorphisms and tuberculosis: updated systematic review and meta-analysis. *Int J Tuberc Lung Dis*. 2010; 14(1): 15-23.

22. Lönnroth, K, Jaramillo, E, Williams, BG, et al. Drivers of tuberculosis epidemics: The role of risk factors and social determinants. *Social Science and Medicine.* 2009; 68: 2240-2246.

23. Cantwell, MF, McKenna, McCray, E, et al. Tuberculosis and Race/Ethnicity in the United States. *Am J respire Crit Care Med*. 1997; 167:1016-1020.

24. Harling, G, Ehrlich, R, Myer, L. The social epidemiology of tuberculosis in South Africa: A multilevel analysis. *Social Science and Medicine.* 2008; 66: 492-505.

25. Cohen A, Mehta S. Pollution and Tuberculosis: Outdoor Sources [electronic article]. PLoS Med. 2007; 4(3): e142.

26. Cook, RT. Alcohol Abuse, Alcoholism, and Damage to the Immune System-A Review. *Alcoholism: Clinical and Experimental Research*. 1998; 22(9): 1927-1942.

27. Friedman, H, Newton, C, Klein, TW. Microbial Infections, Immunomodulation and Drugs of Abuse. *Clinical Microbiology Reviews*. 2003; 16(2): 209-219.

28. Chin, DP, DeRiemer, K, Small, PM, et al. Differences in Contributing Factors to Tuberculosis Incidence in U.S.-born and Foreign-born Persons. 1998; 188: 1797-1803.

29. Cohen, JM, Wilson, ML, Aiello, AE. Analysis of social epidemiology research on infectious diseases: historical patterns and future opportunities. *J Epidemiol Community Health.* 2007; 61: 1021-1027.

30. Kawachi, I. Social Capital and Community Effects on Population and Individual Health. *Annals of the New York Academy of Sciences*. 2006; 896:120-130.

31. Acevedo-Garcia, D. Zip Code-Level Risk Factors for Tuberculosis: Neighborhood Environment and Residential Segregation in New Jersey, 1985-1992. *American Journal of Public Health.* 2001; 91(5): 734-741.

32. Gee, GC. A multilevel analysis of the relationship between institutional and individual racial discrimination and health status. *American Journal of Public Health.* 2002; 92 (4): 615- 623.

33. Harrell, JP, Hall, S, Taliaferro, J. Physiological Responses to Racism and Discrimination: An Assessment of the Evidence. *American Journal of Public Health.* 2003; 93(2): 243-248.

34. Krieger, N, Smith, K, Naishadham, D, et al. Experiences of discrimination: Validity and reliability of a self-report measure for population health research on racism and health. *Social Science and Medicine.* 2005; 61: 1567-1596.

35. Department of Homeland Security. *2009 Yearbook of Immigration Statistics.* Washington, DD: United States of Homeland Security; 2009. (ISSN: 0743-538X)

36. DeRiemer, K, Chin, DP, Schecter, GF, et al. Tuberculosis Among Immigrants and Refugees. *Arch Intern Med*. 1998; 158: 753-760.

37. Zuber, PL, McKenna, MT, Binkin, NJ, et al. Long-term Risk of Tuberculosis Among Foreign-born Persons in the United States. *JAMA*. 1997; 278: 304-307.

38. Frothingham, R, Stout, JE, Hamilton, CD. Current issues in global tuberculosis control. *Journal of Infectious Diseases*. 2005; 9:297-311.

39. Talbot, EA, Moore, M, McCray, E, et al. Tuberculosis Among Foreign-born Persons in the United States, 1993-1998. *JAMA*. 2000; 284: 2894-2900.

40. Graciela, M, Delgado, H. Molecular Epidemiology of Tuberculosis Transmission: Contextualizing the Evidence Through Social Network. *Soc Sci and Med.* 2009; 69: 747-753.

41. Asch, S, Leake, B, Gelberg, L. Does Fear of Immigration Authorities Deter Tuberculosis Patients From Seeking Care? *West J Med.* 1994; 161: 373-376.

42. Littleton, J, Park, J, Thornley, C, et al. Migrants and tuberculosis: analyzing epidemiological data with ethnography. *Australian and New Zealand Journal of Public Health.* 2008; 32(2): 142-149.

43. Rubel, AJ, Garro, LC. Social and Cultural Factors in the Successful Control of Tuberculosis. *Public Health Reports*. 1992; 107(6): 626-636.

44. Bureau of the Census, US Department of Commerce. Census 2000 summary file 3. Washington, DC: Bureau of the Census; 2007. (http://www.census.gov/population/www/cen2000/). (Accessed December 10, 2010).

45. United States Department of Housing and Urban Development. *Measuring Overcrowding in Housing.* Bethesda, MD: Econometrica, Inc.; 2007.

46. Snider, DE, Seggerson, JJ, Hutton, MD. Tuberculosis and Migrant Farm Workers. *JAMA*.1991; 265(13): 1715-1719

47. Chi, PS. Medical Utilization Patterns of Migrant Farm Workers in Wayne County, New York. 1985; 100 (5): 480-490.

48. Kawachi, I, Berkman, LF. Social Cohesion, Social Capital, and Health. In: Berkman, LF, Kawachi eds. *Social Epidemiology.* New York, NY: Oxford University Press; 2000: 174-190.

49. Stansfield,SA. Social Support and Social Cohesion. In: Marmot, Wilkinson, RG eds. *Social Determinants of Health, 2nd ed*. New York, NY: Oxford University Press; 2005:155-178.

50. Holtgrave, DR, Crosby, RA. Social Capital, poverty, and income inequality as predictors of gonorrhea, syphilis, chlamydia, and AIDS case rates in the United States. *Sex Trans Infect*. 2003; 79: 62-64.

51. Kim, D, Subramanian, SV, Gortmaker, SL, et al. US state- and county-level social capital in relation to obesity and physical inactivity: A multilevel, multivariable analysis. *Social Sci and Med.* 2006; 1045-1059.

52. Roper Center for Opinion Research. *Social Capital Benchmark Survey, 2006*. Storrs, CT: University of Connecticut; 2009.

53. Bureau of the Census, US Department of Commerce. Census 2000 summary file 1. Washington, DC: Bureau of the Census; 2007. (http://www.census.gov/population/www/cen2000/). (Accessed December 10, 2010).

54. Bureau of the Census, US Department of Commerce. Census 2000 summary file 2. Washington, DC: Bureau of the Census; 2007. (http://www.census.gov/population/www/cen2000/). (Accessed December 10, 2010).

55. Bureau of the Census, US Department of Commerce. Census 2000 summary file 4. Washington, DC: Bureau of the Census; 2007. (http://www.census.gov/population/www/cen2000/). (Accessed December 10, 2010).

56. Cadge, W, Ecklund, EW. Religious Service Attendance Among Immigrants. *The American Behavioral Scientist*. 2006; 49(11): 1574-1595.

57. Hall, DL, Matz, DC, Wood, W. Why Don't We Practice What We Preach? A Meta-Analytic Review of Religious Racism. *Personality and Social Psychology Review*. 2010; 14(1): 126-139.

58. Binder, S, Levitt, AM, Sacks, JJ, et al. Emerging Infectious Diseases: Public Health Issues for the 21st Century. *Science*. 1999; 284(5418): 1311-1313.

Tables

Table 1: Means of Exposure Variables by Demographic Information for 2000 and 2006 Social Capital Community Benchmark Data

	Mean Faith-based Social Capital[a]		Mean Racial Trust[b]		Mean Support of Immigrants' Rights[c]	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Race						
American Indian/Alaskan Native	-0.18	0.06	--	--	2.85	0.13
Asian/ Pacific Islander	-0.28	0.04	1.98	0.03	3.17	0.07
African American /Black	0.13	0.01	1.83	0.01	2.58	0.03
Hispanic	-0.15	0.01	1.62	0.02	3.00	0.03
White	-0.04	0.01	2.13	0.01	2.67	0.01
Age						
18-24	-0.19	0.02	1.83	0.02	2.58	0.03
25-34	-0.18	0.01	1.94	0.01	2.56	0.02
35-44	-0.03	0.01	1.99	0.01	2.61	0.02
45-54	0.02	0.01	2.10	0.01	2.66	0.02
55-64	0.04	0.01	2.11	0.01	2.85	0.03
65-74	0.16	0.02	2.14	0.02	3.02	0.04
75-84	0.14	0.02	2.18	0.02	3.30	0.05
85+	0.17	0.05	2.12	0.07	3.55	0.11
Gender						
Male	-0.11	0.01	1.97	0.01	2.75	0.17
Female	0.03	0.01	2.04	0.01	2.68	0.01
Year						
2000	-0.06	0.01	2.02	0.01	2.62	0.01
2006	0.06	0.02	1.96	0.01	3.04	0.03

Data from 2000 and 2000 Social Capital Community Survey, using sampling weights
-- indicates missing data (n=154)
[a]= range: -1.11 to 1.56
[b]=range: 0 to 3
[c]=range: 1 to 5

Table 2a: Cross-tabulation of MSAs by Categorized MSA-mean Faith-based Social Capital and MSA-mean Racial Trust

		MSA-mean Racial Trust		
		Low	**Medium**	**High**
MSA-mean Faith-based Social Capital	**Low**	4	3	2
	Medium	3	4	2
	High	2	3	4

Note: MSA-mean Faith-based Social Capital and MSA-mean Race Trust categorized into tertiles based on distribution of MSAs

Table 2b: Cross-tabulation of MSAs by Categorized MSA-mean Faith-based Social Capital and MSA-mean Support of Immigrants' Rights

		MSA-mean Support of Immigrants' Rights		
		Low	**Medium**	**High**
MSA-mean Faith-based Social Capital	**Low**	3	0	6
	Medium	2	6	1
	High	4	2	3

Note: MSA-mean Faith-based Social Capital and MSA-mean Immigrants' Rights Views categorized into tertiles based distribution of MSAs

Table 2c: Cross-tabulation of MSAs by Categorized MSA-mean Racial Trust and MSA-mean Immigrants' Rights View

		MSA-mean Support of Immigrants' Rights		
		Low	**Medium**	**High**
MSA-mean Racial Trust	**Low**	0	3	6
	Medium	3	3	4
	High	6	2	0

Note: MSA-mean Racial Trust and MSA-mean Immigrants' Rights Views categorized into tertiles based on distribution of MSAs

Table 3: Tuberculosis Rates per 100,000 in select MSA's by Demographic and MSA-specific Social Capital variables in 2000 and 2006[a,b]

	Gender		Year		U.S./Foreign Born		Race				
	Male	Female	2000	2006	U.S.-born	Foreign-born	American Indian/ Alaskan Native	Asian/Pacific Islander	African American/ Black	Hispanic	White
Overall	5.01	2.74	7.80	8.10	0.29	2.19	0.01	0.77	1.14	0.74	1.15
Faith-based Social Capital											
Low	5.01	2.95	8.00	0.00	0.22	2.52	0.03	1.47	0.86	1.27	1.03
Medium	5.36	2.76	7.13	10.93	0.35	2.03	0.00	0.54	1.18	0.75	0.93
High	4.52	2.38	8.42	3.94	0.29	2.04	0.00*	0.13	1.44	0.09	1.61
Racial Trust											
Low	3.32	1.86	5.47	2.95	0.16	2.66	0.01	0.44	0.65	0.10	1.28
Medium	5.84	3.19	8.65	12.85	0.31	2.06	0.00	0.99	1.46	0.81	1.21
High	5.57	2.94	9.34	7.27	0.39	1.92	0.01	0.82	1.16	1.10	0.96
Immigrants											
Low	6.86	3.55	11.85	8.76	0.38	22.57	0.01	0.96	1.13	1.22	1.14
Medium	3.67	2.13	6.12	2.95	0.26	1.94	0.00	0.27	1.11	0.25	1.06
High	4.08	2.33	6.50	0.00	0.22	2.31	0.01	0.97	1.17	0.53	1.23

[a]=TB Cases aggregated for the years 1998-2002 and 2004-2008
[b]=exposure variables were categorized into tertiles based on percentage
*=Value due to suppressed TB data

Table 3: Continued

	Age										
	< 1 year	1-4 years	5-14 years	15-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-84 years	85+ years
Overall	2.36	2.49	0.80	2.26	3.03	3.08	3.65	4.17	5.34	6.65	9.39
Faith-based Social Capital											
Low	3.62	2.77	0.92	2.55	3.40	2.97	3.31	4.39	5.71	6.39	7.73
Medium	1.96	2.38	0.85	2.43	3.30	3.36	4.45	4.89	5.52	6.23	8.40
High	0*	1.94	0.33	1.58	2.21	2.87	3.09	3.16	4.48	7.82	16.49
Racial Trust											
Low	1.21	1.21	0.65	1.95	2.12	1.58	1.89	2.39	3.31	4.00	8.22
Medium	4.70	2.74	0.95	2.38	3.20	3.53	4.03	4.78	6.13	7.78	10.81
High	1.30	2.73	0.70	2.47	3.69	4.06	4.86	5.03	6.37	7.97	8.78
Support of Immigrants' Rights											
Low	2.46	3.36	0.95	2.86	4.04	4.32	5.28	6.04	7.35	10.19	11.56
Medium	0.79	1.76	0.53	1.46	2.11	2.44	2.92	3.06	3.93	5.05	6.95
High	3.26	1.77	0.65	2.21	2.77	2.39	2.59	3.12	4.53	5.05	8.59

[a]=TB Cases aggregated for the years 1998-2002 and 2004-2008

[b]=exposure variables were categorized into tertiles based on distribution of MSAs

*=Value due to suppressed TB data

Table 4: Poisson Regression of Correlated Data for Aggregated TB Cases and Demographic Variables in Selected MSAs for the years 2000 and 2006

	Risk Ratio	95% Confidence Interval		P-value
		Lower	Upper	
Sex Model				
2000	1.00	--	--	Ref
2006	1.20	0.92	1.56	0.17
Female	1.00	--	--	Ref
Male	1.61	1.49	1.73	<0.0001**
Age Model				
2000	1.00	--	--	Ref
2006	1.25	0.95	1.66	0.11
<1 year	0.13	0.04	0.47	0.0018**
1-4 years	0.64	0.47	0.88	0.0063**
5-14 years	0.22	0.17	0.28	<0.0001**
15-24 years	0.67	0.60	0.75	<0.0001**
25-34 years	1.00	--	--	Ref
35-44 years	0.97	0.90	1.05	0.48
45-54 years	1.15	1.05	1.27	0.0026**
55-64 years	1.32	1.18	1.47	<0.0001**
65-74 years	1.62	1.39	1.88	<0.0001**
75-84 years	1.87	1.57	2.25	<0.0001**
85 + years	2.09	1.68	2.61	<0.0001**
Race Model				
2000	1.00	--	--	Ref
2006	1.17	1.79	2.44	0.68
American Indian/Alaskan Native	0.02	0.01	0.06	<0.0001**
Asian/Pacific Islander	1.60	0.96	2.67	0.07*
African American/ Black	1.61	1.22	2.13	0.0008**
Hispanic	1.73	1.11	2.70	0.02
White	1.00	--	--	Ref
U.S./Foreign-born Model				
2000	1.00	--	--	Ref
2006	1.21	1.02	1.45	0.03**
Foreign-born	6.35	4.65	8.67	<0.0001**
U.S./Foreign-born	1.00	--	--	Ref

Table 4: Continued				
Race and Sex Model				
2000	1.00	--	--	Ref
2006	1.16	1.03	1.39	0.10*
Female	1.00	--	--	Ref
Male	1.61	1.49	1.74	<0.0001**
American Indian/Alaskan Native	0.62	0.57	0.67	<0.0001**
Asian/Pacific Islander	17.32	14.01	21.39	<0.0001**
African American/ Black	8.29	6.58	10.45	<0.0001**
Hispanic	6.22	4.77	8.11	<0.0001**
White	1.00	--	--	Ref
Age and Sex Model				
2000	1.00	--	--	Ref
2006	1.24	0.92	1.65	0.15
Female	1.00	--	--	Ref
Male	1.70	1.59	1.81	<0.0001**
<1 year	0.06	0.01	0.23	<0.0001**
1-4 years	0.27	0.22	0.33	<0.0001**
5-14 years	0.22	0.17	0.28	<0.0001**
15-24 years	0.67	0.60	0.75	<0.0001**
25-34 years	1.00	--	--	Ref
35-44 years	0.98	0.91	1.05	0.52
45-54 years	1.16	1.06	1.27	<0.0001**
55-64 years	1.33	1.19	1.49	<0.0001**
65-74 years	1.65	1.42	1.91	<0.0001**
75-84 years	1.98	1.66	2.37	<0.0001**
85 + years	2.37	1.92	2.93	<0.0001**
U.S./Foreign-born and Sex Model				
2000	1.00	--	--	Ref
2006	1.21	1.02	1.45	<0.0001**
Female	1.00	--	--	Ref
Male	1.60	1.50	1.72	<0.0001**
Foreign-born	6.26	4.57	8.58	<0.0001**
U.S./Foreign-born	1.00	--	--	Ref

Table 4: Continued				
U.S./Foreign-born and Race Model				
2000	1.00	Ref	Ref	Ref
2006	1.17	0.72	1.01	0.07*
American Indian/Alaskan Native	3.27	1.47	7.29	0.004**
Asian/Pacific Islander	5.60	4.93	6.35	<0.0001**
African American/ Black	8.75	6.99	10.94	<0.0001**
Hispanic	2.71	2.13	3.45	<0.0001**
White	1.00	Ref	Ref	Ref
Foreign-born	4.74	3.52	6.37	<0.0001**
U.S./Foreign-born	1.00	Ref	Ref	Ref
Sex Model[a]				
2000	1.00	Ref	Ref	Ref
2006	0.79	0.64	0.97	0.03**
Female	1.00	Ref	Ref	Ref
Male	1.44	1.35	1.54	0.03**
Race Model[a]				
2000	1.00	Ref	Ref	Ref
2006	0.78	0.64	0.95	0.01**
American Indian/Alaskan Native	0.30	0.04	2.18	0.23
Asian/Pacific Islander	5.55	4.73	6.50	<0.0001**
African American/Black	9.10	5.24	15.81	<0.0001**
Hispanic	2.39	1.88	3.03	<0.0001**
White	1.00	Ref	Ref	Ref

[a]= Foreign-born only model
*= indicates significance at p=0.10
**=indicates significance at p=0.05

Table 5: Poisson Regression of Correlated Data for Aggregated TB Cases and Exposure Variables in Selected MSAs for the years 2000 and 2006

	Risk Ratio	95% Confidence Interval		P-value
		Lower	Upper	
Sex Models[a]				
Faith-Based Social Capital	0.71	0.30	1.71	0.45
Racial Trust[e]	0.35	0.04	3.19	0.35
Immigrant Rights Support[g]	2.21	1.14	4.28	0.02**
Age Models[b]				
Faith-Based Social Capital	0.68	0.28	1.64	0.39
Racial Trust[e]	0.31	0.03	2.81	0.30
Immigrant Rights Support	1.50	0.86	2.63	0.15
Race Models[c]				
Faith-Based Social Capital	0.53	0.20	1.42	0.21
Racial Trust[e]	0.92	0.14	6.08	0.93
Immigrant Rights Support	1.39	0.85	2.28	0.19
U.S./Foreign-born Models[d]				
Faith-Based Social Capital	2.01	0.97	4.16	0.06*
Racial Trust[e]	0.55	0.09	3.51	0.53
Immigrant Rights Support	1.12	0.78	1.61	0.53
Race and Sex Models[a,c]				
Faith-Based Social Capital	1.54	1.04	2.29	0.03**
Racial Trust[e]	0.94	0.14	6.19	0.95
Immigrant Rights Support	1.20	0.90	1.61	0.21
Age and Sex Models[a,b]				
Faith-Based Social Capital	0.68	0.28	1.65	0.40
Racial Trust[e]	0.35	0.04	3.28	0.36
Immigrant Rights Support	1.91	0.96	3.79	0.06*
U.S./Foreign-born and Race Models[c,d]				
Faith-Based Social Capital	1.63	1.12	2.39	0.01**
Racial Trust[e]	0.85	0.15	4.69	0.85
Immigrant Rights Support	1.17	0.85	1.61	0.35

Table 5: Continued				
U.S./Foreign-born and Sex Models[a,d]				
Faith-Based Social Capital[h]	3.81	1.34	10.85	0.01**
Racial Trust[e]	0.54	0.09	3.38	0.51
Immigrant Rights Support	1.14	0.80	1.64	0.47
Sex Models[a,f]				
Faith-Based Social Capital	0.86	0.68	1.62	0.31
Racial Trust[e]	1.16	0.08	17.68	0.91
Immigrant Rights Support	0.85	0.62	1.15	0.29
Race Models[c,f]				
Faith-Based Social Capital	1.35	0.60	3.03	0.47
Racial Trust[e]	0.64	0.07	5.75	0.69
Immigrant Rights Support	1.09	0.76	1.56	0.63

Note: all models adjusted for year and all risk ratios reported by a 1-standard deviation increase of exposure variables

[a]= adjusted for sex

[b]= adjusted for age

[c]= adjusted for race

[d]= adjusted for U.S./Foreign-born Status

[e]= adjusted for proportions of Asians, Blacks, Hispanics and Whites in each MSA

[f]=model containing only Foreign-born TB cases

[g]= included sex and support of immigrants' rights interaction term

[h]= included sex and faith-based social capital interaction term

*= indicates significance at p=0.10

**=indicates significance at p=0.05

Appendix 1

EMORY UNIVERSITY | Institutional Review Board

TO: Christine Miner
Principal Investigator

DATE: October 20, 2010

RE: **Notification of Submission Determination: No IRB Review Required**
IRB00047130
Social Capital and TB: Does Social Capital Affect TB Case Rates in Immigrants

The above-referenced study has been vetted by the Institutional Review Board (IRB), and it was determined that it does not require IRB review because it does not meet the definition of "Research involving Human Subjects" or the definition of "Clinical Investigation" under applicable federal regulations. The PI will conduct a secondary data analysis of de-identified, aggregated data. The publicly available datasets will be obtained from the Social Capital Community Benchmark Survey (SCCBS) and the Online Tuberculosis Information System (OTIS). Accordingly, IRB review is not required.

45 CFR Section 46.102(f)(2) defines "Research involving Human Subjects" as follows:

> Human subject means a living individual about whom an investigator (whether professional or student) conducting research obtains:
>
> (1) data through intervention or interaction with the individual, or
> (2) identifiable private information
>
> Intervention includes both physical procedures by which data are gathered (for example, venipuncture) and manipulations of the subject or the subject's environment that are performed for research purposes. Interaction includes communication or interpersonal contact between investigator and subject. Private information includes information about behavior that occurs in a context in which an individual can reasonably expect that no observation or recording is taking place, and information which has been provided for specific purposes by an individual and which the individual can reasonably expect will not be made public (for example, a medical record). Private information must be individually identifiable (i.e., the identity of the subject is or may be ascertained by the investigator or associated with the information) in order for obtaining the information to constitute research involving human subjects.

Please note that any changes to the protocol could conceivably alter the status of this research under the federal regulations cited above. Accordingly, any substantive changes in the protocol should be presented to the IRB for consideration prior to their implementation in the research.

Sincerely,

Carol Corkran, MPH, CIP
Senior Research Protocol Analyst
This letter has been digitally signed

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