2016

Risk Factors for Tuberculosis and Multidrug-Resistant Tuberculosis Complications among Foreign-Born Persons in Houston, Texas

James N. Isaboke
Walden University

Walden University

College of Health Sciences

This is to certify that the doctoral dissertation by

James Isaboke

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Nicoletta Alexander, Committee Chairperson, Public Health Faculty
Dr. Scott Hershberger, Committee Member, Public Health Faculty
Dr. David Segal, University Reviewer, Public Health Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2016

Abstract

Risk Factors for Tuberculosis and Multidrug-Resistant Tuberculosis Complications among Foreign-Born Persons in Houston, Texas

by

James N. Isaboke

MS, Texas Southern University, 2010

MS, University of Nairobi, 1980

BS, University of Nairobi, 1975

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Epidemiology

Walden University

January, 2016

Abstract

Tuberculosis (TB) is a leading public health problem across the world. For various reasons, TB and multidrug-resistant tuberculosis (MDR-TB) have increased. Clarification on TB/HIV co-infection and homelessness as risk factors for TB and MDR-TB is required to inform policy interventions to reduce TB-related morbidity, mortality, and healthcare costs. In this quantitative study, data from the Houston Health Department (N = 341) were analyzed to explore the relationship between TB and MDR-TB outcomes and TB/HIV co-infection and type of housing/homelessness. Foreign-born persons are disproportionately affected in the United States. The socio-ecological model provided a theoretical framework for the investigation. Multiple and logistic regression analyses were conducted to investigate the relationships between variables, controlling for age and gender. Results indicate that HIV infected persons were more likely than non-infected persons to contract TB, and homeless persons were more likely than non-homeless persons to contract TB/MDR-TB, suggesting that high TB/HIV co-infection rates increase prevalence of TB and MDR-TB while improvements in housing reduce prevalence of TB and MDR-TB. However, no significant associations between variables were found. The odds ratio, Exp(B) = 0.000, $p \geq 0.90$, 95% Cl [0.000, with no upper bound values] was observed for both independent variables. Regular screening for TB/HIV co-infection among persons with high TB and MDR-TB risk profiles is recommended. Further investigation is required. Inclusion of more covariates could further elucidate more evidence of an association between variables. Study findings may support interventions to reduce TB-related morbidity, leading to positive social change.

Risk Factors for Tuberculosis and Multidrug-Resistant Tuberculosis Complications among Foreign-Born Persons in Houston, Texas

by

James N. Isaboke

MS, Texas Southern University, 2010

MS, University of Nairobi, 1980

BS, University of Nairobi, 1975

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Epidemiology

Walden University

January, 2016

Dedication

This dissertation is dedicated to the following people: My wife, Ruth Kerubo Nyarenchi, for her unswerving support and patience enduring my long absence attending to a paucity of study activities and events throughout the dissertation and doctoral study process. My mother, Peris Moraa, and father, Matagaro Mirambo, who instilled in me a passion for higher purpose, tenacious spirit of learning, and inspiration to excel in my endeavors. During this entire process, Almighty God has always been my helper, protector, and provider of strength to succeed.

Acknowledgement

Many people have made invaluable contribution to my dissertation and the doctoral study process. First, I would like to express my sincere thanks and appreciation to the Walden University community, particularly my dissertation chair Dr. Nicoletta Alexander for her epidemiologic expertise, exemplary guidance, and mentorship; Dr. Scott Hershberger, my methodology expert, and Dr. David Segal, the URR representative on my supervisory committee, for their unfailing support. My university professors, university administrative team, technical support, library personnel, and many of my classmates have been a source of encouragement, inspiration, and determination during this entire grueling, nevertheless, empowering, and humbling experience. I would also like to thank my wife Ruth Kerubo Nyarenchi once again, my children, and grandchildren for their patience, understanding, and support throughout the doctoral journey and dissertation process. Without the input of all these people, it would not have been possible to report the achievements and outcome of my doctoral enterprise, and I am deeply indebted and honored by their generous contributions towards the accomplishment of this dissertation process, and the doctoral studies in particular.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Tuberculosis (TB) is a major killer today. TB seemed manageable several decades ago, but now has re-resurged as a public threat in the United States and internationally because of socio-economic circumstances the advent of HIV/AIDS, and other factors (El Sahly, Teeter, Pawlak, Musser, & Graviss, 2006). Previous researchers have linked the prevalence of tuberculosis to HIV infections, and poor or crowded housing conditions (Garcia, 2004). Almost two decades has passed since the World Health Organization declared tuberculosis a global emergency, yet TB still remains a leading cause of death (Horne et al., 2012). According to the World Health Organization (WHO, 2013a), TB is second only to HIV/AIDS as the leading cause of death globally due to a single infectious agent. One third of the world's population is estimated to have latent tuberculosis which is not active TB disease yet (Horne et al., 2012). A large portion of the world population continues to be infected with tuberculosis.

New cases of tuberculosis are reported daily. Someone becomes infected with the TB bacterium every second somewhere around the globe (Butler & Carr, 2013). In 2011, 9 million new cases of TB infections were reported, and 1.4 million persons died from the disease worldwide (Centers for Disease Control and Prevention [CDC], 2012a; WHO, 2013a). Experts estimate that 1 billion people worldwide will become infected with the TB bacterium by 2020, and that more than 150 million of these people will develop the disease and 36 million will die (Butler & Carr, 2013). The TB prevalence trajectory makes the case for addressing the prevalence and incidence of tuberculosis the more urgent.

In addition, emerging new forms of tuberculosis complications makes eradication of tuberculosis even more urgent and necessary. Multidrug-resistant (MDR-TB) and extensively drug-resistant tuberculosis (XDR-TB) continue to emerge in high HIV prevalence settings, and the mortality of HIV co-infected patients remains high (Andrew et al., 2010; WHO, 2013a). WHO sought to reduce TB prevalence and mortality globally by 50% by 2015, as compared to 1990 baseline figures (WHO, 2013a). To achieve this goal, WHO encouraged United Nations (UN) member countries to embrace Direct Observed Therapy (DOT) for treatment of TB patients. The WHO Stop TB Strategy (2006-2015) envisions a TB-free world, and its overarching goal is to halt and reverse the incidence of TB by 2015 (WHO, 2004). However, novel strategies are needed to address the prevalence and incidence of tuberculosis both globally and in the United States to achieve a TB-free world.

More effective strategies for treatment of tuberculosis are being formulated to reduce prevalence and incidence of tuberculosis. DOT is the heart of the Stop TB Strategy in the United States. It is the most effective strategy for ensuring that patients take their medication as prescribed by their physicians (CDC, 2013a). The health worker watches the patient swallow every dose of the prescribed drug (CDC, 2013a). DOT can be given anywhere convenient both to the healthcare provider and patient, and should be considered for all TB patients because it is difficult to reliably predict non-adherence. The five core elements of DOT include: political commitment with increased and sustained financing; case detection through quality-assured bacteriology; standardized treatment with supervision and patient support; effective drug supply and management systems, monitoring and evaluation of TB patients, and impact assessment (CDC, 2013a).

The main strengths of DOT include ensuring patient adherence to, and compliance with, the treatment regimens; monitoring drug side-effects and responses to the therapy; elimination of potential treatment interruptions; and ensuring that the patient takes appropriate medication, thus minimizing potential dangers of drug resistance build-up (WHO, 2013a). Further policy interventions to enhance and sustain efforts against TB are needed.

In this study, I sought to elucidate risk factors for high TB prevalence and MDR-TB complications among foreign-born populations in Houston, Texas. Sufficient understanding of the predictors of TB and MDR-TB among foreign-born persons (persons who have come to the United States either as immigrants or refugees),is important for the formulation of appropriate public health policy interventions for the elimination of TB morbidity, mortality, and associated economic costs in the United State States. National economic cost inflicted upon the United States by tuberculosis related events is enormous in terms of mortalities, loss in productivity related to morbidity and healthcare cost.

. In this chapter, I will present background information on TB and discuss my problem statement, study purpose, research questions and hypotheses, key definitions, assumptions, scope, and limitations, and significance of my study.

Background on the Problem

There is need for better understanding of interpersonal and intrapersonal influences on the prevalence and incidence of tuberculosis to inform appropriate policy interventions in the prevention and control of tuberculosis in the United States. Currently, information on the interaction of contextual and individual risk factors for TB and MDR-

TB disparity among foreign-born persons in the US is inadequate. Previous studies have demonstrated contextual and/or individual risk factor interactions for TB infections in the U.S-born populations (Novignon & Nonvignon, 2012; Wu & Dalal, 2012). Some studies have shown contextual and/or individual risk factor interactions for TB infections, such as smoking and latent TB (Horneet al., 2012), HIV co-infection (Alavi, Nadimi, Shokri, & Zamani, 2010; Garfein et al., 2010; Kendall, 2012;), type of housing e.g. being in jail/prison, living in crowded housing, and homelessness (Texas Department of State Health Services [TDSHS], 2012; Garfein et al., 2010; Sanders, Olive, Wallace, Lacy, Leyba, & Kendiny, 2001), age (Chan-Yenung, Chan, Cheung, Dan, & Chu, 2006; Winston & Narin, 2010),co-infection with diabetes mellitus (Balakrishrian, Vijayan, Nair, Subramoniapillai & Mrithyunjayan, 2012; Restrepo, Carmerlin, Rahbar, Wang & Restrepo, 2011), drug resistance (Andrew et al., 2010) ; Mushiff et al., 2006; Ocheretina, Morose, Joseph, D'Meza, & Escuyer, 2012), household TB contact (Madico, Gilman, Cabrera, Kacena, & Dia'z, n.d.), and failures to screen (Stahl, 2012) . But no such interactions have been documented for foreign-born TB patients in the US. Oren, Winston, Pratt, Robison, and Narita (2010), recommend continuing investigations on the challenges of urban TB in the United States that examine different groupings of cities, chosen to reflect the demographic diversity of the United States. Although some surveys in Texas have linked alcohol abuse with the prevalence of TB (TDSHS,2012), I did not investigate this variable as it required generation of primary data which was not feasible for this study using secondary source of data and due to financial and time constraints.

Tuberculosis is caused by the bacterium *Mycobacterium tuberculosis.* Also known as Koch's bacillus, the small, rod shaped bacterium was discovered by Dr. Robert

Koch in 1882 (Butler & Carr, 2013). The bacterium is found only in people and not in other living organisms, and it requires oxygen to survive (Butler & Carr, 2013). TB is contagious and is transmitted from person to person through tiny droplets in the air- for example, as when an infected person coughs, sneezes, talks or spits and another healthy person inhales the infected air (Butler & Carr, 2013; Kendall, 2012). Individuals infected with TB can either have latent TB infection (LTBI) or active TB. Those with LTBI do not exhibit symptoms and cannot spread the disease, while active cases exhibit a range of symptoms and are contagious (Kendall, 2012). Without treatment, contagious individuals will infect an average of 10-15 people each year and eventually die (Kendall, 2012). Tuberculosis usually affects the lungs, although it may also affect other parts of body including the brain, kidneys, and the spine (Butler & Carr, 2013). Symptoms may include weakness, fever, prolonged coughing (sometimes with coughing up of blood), and chest pain (Kendall, 2012). TB may be fatal if it is not properly treated. It may also be fatal for infected people who are resistant to the two most powerful first-line TB treatment drugs (CDC, 2013a; Kendall, 2012). Multidrug-resistant TB is increasing worldwide due to due multiple factors including wrong treatment dosage, non-adherence to recommended treatment regimens, and lack of commitment to develop more effective and safe drugs.

Tuberculosis Burden in the United States

Despite significant investments and research efforts TB has reemerged as an important public health problem in the United States in recent years, particularly among the foreign-born populations (NIH, 1998). In 2011, a total of 10,528 TB cases (which is 3.4 cases per 100,000 residents) were reported in the US with 529 deaths (CDC, 2012b). In 2012, 9,951 new cases were reported, an incidence rate of 3.2 per 100,000 population.

Of the cases reported in 2012, 63% occurred among foreign-born persons. The TB rate among foreign-born persons in 2012 (15.9 cases/100,000) was 11.5 times as high as that among U.S.-born persons (i.e., 1.4/cases per 100,000 residents; CDC, 2012b). The development of MDR-TB in the US since 1993 that do not respond to the first-line drugs currently used for TB treatment- is a matter of serious concern. Since 1998, the percentage of U.S.-born patients with MDR-TB has remained below 1% of the total MDR-TB cases(CDC, 2013a). However, the percentage of foreign-born persons with MDR-TB increased from 31% (149 of 480) in 1992 to 87.8% (72 of 82) in 2012. The emergence of drug-resistant forms of TB, which was uncommon 20 years ago (Abubakar, Zignol, & Falzon, 2013; Andrew et al., 2010), presents a major challenge to health care community. In addition, strains of exclusively drug resistant tuberculosis (XDR-TB) also continue to emerge (Andrew et al., 2010). Effects of TB may also be more negative for patients with XDR-TB(Andrew et al., 2010). This calls for interventions not only for reducing prevalence of TB, but also for elimination of the development of multidrug-resistant TB.

TB Burden in Houston

In 2012, 1,233 cases of TB were reported in Texas (a rate of 4.7 per 100,000 population), of which 195 cases were reported in Houston, (a rate of 8.5 per 100,000 population; TDSHS,2012). In addition, a total of 139 suspected cases of TB were reported in Houston in 2012 (HDHHS,2013a) . Cases of TB reported in Houston by place of birth have declined among U.S-born persons since 2002, while the incidence and prevalence rates of TB among foreign-born persons have shown an increase over the same time period (HDHHS, 2013a). In a study of patients treated between 1993 and 2002

with XDR-TB within Houston, 64% were more likely to die than patients with MDR-TB (El Sahly et al., 2006). Currently, there is no vaccine proven to prevent pulmonary TB, which is the most common type among foreign-born TB patients in Houston (El Sahly et al., 2006). The Houston Metropolitan Statistical Reporting Area was ranked third in the nation and first in Texas for 2011 in incidence of TB (HDHHS, 2013a). These trends indicate that TB and MDR-TB are serious public health problem in Texas, and Houston in particular.

The Economic Impact of Tuberculosis

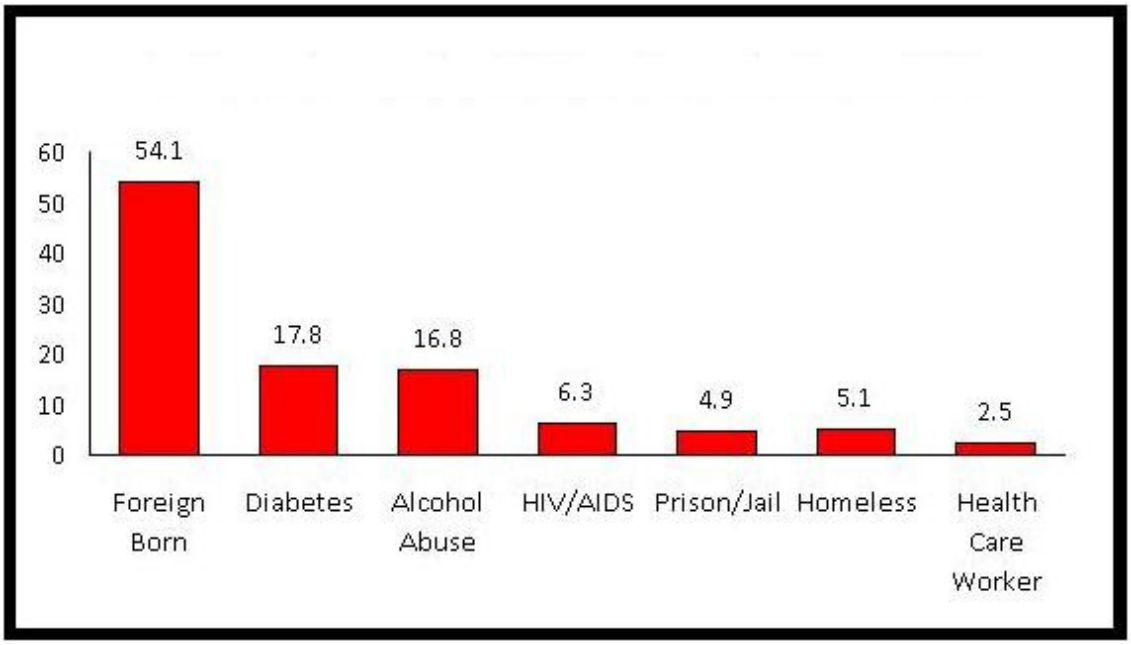
Direct costs, mostly covered by the public sector, average $134,000 per MDR TB patient and $430,000 per XDR TB patient. In comparison, the estimated average cost for a non-MDR TB patient is $17,000 (Mark et al., 2014). It costs approximately $483,000 to treat one case of XDR-TB in hospital, and approximately $225 to treat one case of MDR-TB in the United States (Abubakar et al., 2010 ; CDC, 2010a). Although drug-resistant TB is usually treatable, anti-drug regimens using second-line antibiotics are generally much more time-intensive and - expensive than first-line antibiotics, and they may produce more severe adverse outcomes than treatment with first-line antibiotics (El Sahly et al., 2006).The economic cost of TB to the United States is enormous. In 2009, the annual national cost of TB was estimated at $ 37.2 billion, including $20.9 billion in direct health care costs, $7.4 billion in indirect morbidity costs, and $8.9 billion in indirect mortality costs (Miller & Washington, 2009). According to the Health People 2020,the US target is to achieve a TB prevalence rate of 1 case/100,000 by 2020 (American Lung Association, 2013; Healthy People 2020, 2014). In this investigation, I

seek to make a contribution to the realization of the Healthy People 2020 objectives on the eradication of tuberculosis in the United States.

Problem Statement

Several researchers have previously investigated the problem of TB in the United States. Oren et al.(2010) found that TB patients in 48 U.S. cities accounted for 36% of all U.S. TB patients. The average TB incidence rate in the 48 cities (12.1 per 100,000 residents) was higher than the national average of 3.2 per 100,000 residents. Nineteen cities had decreasing rates; however, 29 cities, including Houston, had non-decreasing rates among foreign-born populations. The researchers determined that a significant TB burden occurs in large cities and that the foreign-born populations were disproportionately affected. Based on their findings, Oren et al. (2010) recommended that studies of city-level variation in migration, socio-economic status, and resources were needed to improve urban TB control. The Texas Department of State Health TB literature reports being foreign-born as a risk factor for TB infection (TDSHS, 2013a; Figure1). However, no specific contextual or individual risk factors influencing high TB disparity among foreign-born persons in Houston have been elucidated. Interactions among contextual and individual risk factors create unique epidemiological risk factor pathways for contracting TB by foreign-born residents in the US, complicating the magnitude and severity of TB and public health efforts in the control and prevention of TB.

Figure 1: Risk Factors Associated with TB Cases Reported in Texas in 2012



Source: Texas DSHS, 2012- TB Statistics: http://www.dshs.state.tx.us.idcu/disease/tb/statistics

Purpose of the Study

In this study I sought to examine the relationships between being infected with HIV, type of housing/residence, TB prevalence, and MDR-TB complications among foreign-born populations, in Houston. The incidence and prevalence of TB and MDR-TB decline among U.S-born population in Houston is not the same and true for their foreign-born counterparts. In this a quantitative study I examined the potential associations between being infected with HIV among foreign-born populations in Houston Texas who also have TB or MDR-TB complications. I further evaluated whether or not the type of housing (residence) had any effect on these potential relationship(s). Texas Department

of State Health Services identify poor housing conditions or living in jail as a risk factor for tuberculosis (TDSHS, 2012).

Independent variables in this study included diagnosis of HIV and type of housing/residence. Outcomes of TB and/or MDR-TB were dependent variables. Demographic characteristics of age and gender were treated as covariates to control for their confounding effects on the response variables. My findings in this study will contribute to inform appropriate public health policy interventions to effectively address the burden of TB and MDR-TB complications among foreign-born persons in an effort to meeting the Healthy People 2020 objective 11D-29 (Healthy People, 2014) in the elimination of TB in the United States.

Research Question(s) and Hypotheses

I addressed the following research questions with corresponding in alternative (A) and null (0) hypotheses in this study:

RQ1: Is being infected with HIV associated with the prevalence of TB among the foreign-born populations in Houston?

$H_0$1: There is no relationship between being infected with HIV and prevalence of TB among the foreign-born populations in Houston.

$H_1$1: Being infected with HIV is related to prevalence of TB among foreign-born populations in Houston.

RQ2: Is being infected with HIV associated with the prevalence of MDR-TB complication among foreign-born populations in Houston?

$H_0$2: There is no relationship between being infected with HIV and the prevalence of MDR-TB complication among the foreign-born populations in Houston.

$H_2$2: Being infected with HIV is related to prevalence of MDR- TB complication among foreign-born populations in Houston.

RQ3: Is housing type associated with the prevalence of TB among the foreign-born populations in Houston?

$H_0$3: There is no relationship between type of housing and prevalence of TB among foreign-born populations in Houston.

$H_3$3: Type of housing is associated with TB prevalence among foreign-born populations in Houston.

RQ4 Is housing type associated with the prevalence of MDR-TB complication among the foreign-born populations in Houston?

$H_0$4: Type of housing is not related to the prevalence of MDR-TB complication among foreign-born populations in Houston

$H_4$4: Type of housing is related to prevalence of MDR-TB complication among foreign-born populations in Houston.

The independent variables, TB/HIV co-infections, and type of housing/residence, as well as the dependent variables, TB and MDR-TB outcomes and the covariates age, and gender were measured in the nominal levels.

Theoretical Framework for the Study

I employed the Social Ecological Model (SEM**),** also known as ecological model, in the design and conduct of this study. Social ecological perspective is a methodological framework used in social science studies to examine the dynamic relationships between individuals and multiple levels of social environment. It is grounded in biological sciences and ecology (Bronfenbrenner, 1994) - the term ecology refers to the study of relationships between organisms and their environment. The ecological perspective essentially takes into account the influence of environmental factors at multiple levels (e.g. family, organization, community, nation) that shape individuals' behaviors and their susceptibility to disease. The field of social ecology, which emerged in the mid-1960s and early 1970s, gives greater attention to social, institutional, and cultural contexts of people-environmental relations, and provides the lenses through which the interdependence among people, their health, and their environment may be conceptualized (Stokol, 1996). The SEM is premised on the fact that human beings, like other living organisms, are influenced by their ecosystems, and that ecosystems exert their influence on individuals ranging from intrapersonal, interpersonal, institutional, and community levels. In this context, therefore, individuals and their intrinsic characteristics are nested within a series of contextual environmental influences. Social and physical environments influence interactions between individuals and contextual factors. The model has been used to design several public health studies and interventions in a number of countries including, Canada, Germany, the Republic of Korea, and the United States (CDC, 2013b; WHO, 2013b; de Wit & Adam, 2012).

The Institute of Medicine has recognized SEM as the principal theoretical framework for framing public health programs in the United States by pulling together efforts of the stakeholders in the public health arena for the common purpose of ensuring healthy communities (IOM, 2003).The Centers for Disease Control and Prevention has adopted SEM as the overarching framework for its health promotion programs, involving multiple bands of influence from individual, interpersonal, organizational, community and policy levels for the prevention and control of colorectal cancer (CDC, 2013b) and violence prevention (CDC, 2009a). The World Health Organization employed the SEM framework-based evidence to explain why some people or groups are at a higher risk of interpersonal violence, while others are more protected from it; where the SEM framework has been used to visualize interpersonal violence as the outcome of interaction among many factors at individual, relationship, the community, and the societal levels (WHO, 2013b).

Ali and Naylor (2013) used the same model to explain the phenomena of intimate partner violence. Fleury and Lee (2006) used the SEM to investigate social and contextual correlates (e.g. social norms, environment, social networks, and organizational support) influencing the adoption and maintenance of regular physical activity among minority and underserved populations in the United States. In the Wilking, Hohle, Velasco, Suckau and Eckmanns study (2012), SEM provided the theoretical framework to describe, in an ecological analysis, the impact of different social factors on the risk of acquiring infectious diseases, with particular reference to rotavirus infections in Berlin, Germany. Edberg, Clear, and Vyas (2011) assessed the diachronic interaction of ecological factors contributing to health disparities among immigrant/refugee populations

using the SEM. Most recently, Li, and Rukavina (2012) utilized the SEM theoretical framework in studying the most effective strategies for inclusion of overweight or obese students in physical activities at schools. The ecological framework has been used to identify and implement ecological tobacco control programs in health promotion programs in Canada (Richard, Lehoux, Breton, Denis, Labrie & Leonard, 2004).

SEM provided a theory-based framework to characterize the nature and results of interventions conducted through larger public and private partnerships in the design of the Food Stamp Program for low-income populations in the United States (Gregson, Foerster, Orr, & Jones, 2001). Lee, Kim, and Lee (2010) used the SEM to study the impact of mass-produced public housing apartments on social exclusion, conflict, and social health promotion in the Republic of Korea. The ecological model has also been used as the theoretical framework to guide the study of interaction of individuals' awareness, preferences, skills, and social environment in the influence of behavioral practices implicated in the transmission and prevention of HIV (de Wit & Adam, 2012).

From the foregoing, the social ecological theory provided a logical framework for the epidemiological study of the TB and MDR-TB complications. The SEM permitted an understanding of the multilevel social and biophysical factors that predict prevalence of tuberculosis and multidrug-resistant tuberculosis complications among individuals in the population under study. I employed the SEM in this study to guide an evaluation of the predictors of TB prevalence and MDR-TB complications among foreign-born populations, in a setting of declining prevalence of TB and MDR-TB in the U.S-born population in Houston.

Nature of the study

In this quantitative study, I undertook a retrospective analysis of secondary data archived by Houston Department of Health and Human Services, Bureau of tuberculosis database. I employed multiple regression analysis to determine multiple influences on TB and MDR-TB complications among foreign-born TB patients. I adopted a retrospective study design for this study because of its time and cost efficiency, and did not expose study participants to additional harm due to intervention effects (Kelder, 2005). Retrospective study design also allows assignment of diagnosis prior to assessment of complications, permitting risk precede the outcome (Riegelmak & Hirsh, 1996). Key independent variables in the analysis included diagnosis of TB/HIV co-morbidity, and type of housing/residence, while outcomes of TB and MDR-TB were the dependent variables. I treated age, and gender attributes as covariates to control for their confounding effects on the outcome variables.

The introduction of electronic health records at healthcare facilities has created opportunities for identifying and monitoring risks and outcomes of TB and MDR-TB infections and treatments since patient medical record such as the demographics, health problems, medications, vital signs, past medical history, immunizations, laboratory data, and radiology report now reside in electronic health record (CMS, 2013). The data for this study were extracted from the discharge medical records at HDHHS, Bureau of Tuberculosis database. The fields I utilized in the study plan included data from the observation cases (i.e. patient information), encounter (i.e. provider visit details), diagnosis, and observation tables. I performed data analysis to examine association between being infected with HIV, type of housing/residence, prevalence of TB, and

MDR-TB complications among foreign-born populations in Houston using SPSS version 21 for Windows software.

Definitions of Terms

General Definitions

I adopted the following definitions for the following terms for the purpose of this study as follows:

Tuberculosis. Tuberculosis (TB) is the disease caused by the bacteria Mycobacterium tuberculosis. TB affects lungs, but can also affect other parts of the body such as the brain, the kidneys, and spine, and is fatal if not properly treated. People with compromised immune system are particularly susceptible to TB infection (CDC, 2012a) .

Mycobacterium tuberculosis. This is a rod-shaped bacterium that causes TB in humans. It is spread from person to person through the air, such as when a person with infectious TB coughs, sneezes, talks, or sings, droplets containing M. tuberculosis and is inhaled by another person (CDC, 2012a).

Latent TB infection. A condition in which TB bacteria are alive but inactive in the body. People with latent TB infection have no symptoms, do not feel sick, can't spread TB to others, and usually have a positive skin test reaction. But they may develop TB disease if they do not receive treatment for latent TB infection (CDC, 2012a).

Active TB disease. an illness in which TB bacteria are multiplying and attacking a part of the body, usually the lungs. The symptoms of TB disease include weakness, weight loss, fever, no appetite, chills, and sweating at night. Other symptoms of TB disease depend on where in the body the bacteria are growing. If TB disease is in the lungs (pulmonary TB), the symptoms may include a bad cough, pain in the chest, and

coughing up blood. A person with TB disease may be infectious and spread TB bacteria to others (CDC, 2012a).

Tuberculin Skin Test. The TB skin test (also known as Monteux tuberculin skin test) performed by injecting 0.1 ml of tuberculin purified protein derivative (PPD) into the inner surface of forearm. The skin test should be read between 48 and 72 hours after administration (CDC, 2012a).

Positive Skin Test. An induration of more than 5 mm is considered positive, meaning the person's body reacted and is infected with TB bacteria, and additional tests may be required to determine if the person has latent or TB infection (CDC, 2012a).

Negative Skin Test. Means the person's body did not react to the test and that latent and TB is unlikely (CDC,2012a).

TB Blood Test. Blood test (also called Interferon-gamma release assay or IGRA) measures how strong the body's immune system reacts to M. tuberculosis. Positive IGRA means that the person has been infected with TB bacteria, while negative IGRA denotes no reaction and latent infection and TB disease is unlikely (CDC, 2012a).

X-Ray Test. Also called CT scan, is a test to diagnose TB in other parts of the body and to detect lung cavities caused by tuberculosis disease (CDC, 2012a).

Screening. Early detection of the TB by tuberculosis skin test, tuberculosis blood test, or X-ray test. Screening for TB is the most effective strategy for the control of TB (CDC, 2012a).

Multidrug-resistant tuberculosis (MDR-TB). Is a form of tuberculosis that is resistant to two or more of the primary drugs (isoniazid and rifampin) used for TB treatment (CDC, 2012a).

Extremely drug-resistant TB (XDR-TB). Is resistant at least to isoniazid and rifampin and to any fluoroquinolone and at least one of the three second-line injectable drugs: Capreomycin, Kanamycin, or Amikan (CDC, 2012a).

Drug abuse. Use of illicit drugs, or improper use of prescriptions drugs, or over the counter drugs, or injection drug use and sharing needles with the case (NIDA,2013).

Healthcare access. Receiving healthcare regularly and on a continuous basis.

Household contact. Household contact of a case who have spent at least 4 hours/day on average in the last 7 days or 24 hours/week with the case (NIDA, 2013).Add citation

Incarceration. Being in prison or detention facility.

Nutritional status. Extent to which nutrients are available to meet metabolic needs.

Socioeconomic status. An individual's position within a hierarchical structure depending on a combination of variables including occupation, education and income (CDC, 2014).

Definitions of Independent Variables

The independent variables are defined for this study as follows:

TB/HIV co-infection. The presence of TB and HIV in the same person at the same time, and associated with worse health outcomes (CDC, 2012a), measured at nominal level.

Type of Housing/Residence. Place of regular residence. This variable was also coded at nominal level of measurement.

Definitions of Dependent Variables

The dependent variables are defined for this study as follows:

Multidrug-resistant tuberculosis (MDR-TB). Is a form of tuberculosis that is resistant to two or more of the primary drugs (isoniazid and rifampin) used for TB treatment (CDC, 2012a).

TB (Active) disease. An illness in which TB bacteria are multiplying and attacking a part of the body, usually the lungs (CDC, 2012a).

Definitions of Covariates

The covariates were defined for this study as follows:

Age. Time period between date of birth and diagnosis of TB measured in years.

Gender. The state of being male (masculine) or female (feminine*)*

Assumptions

It was assumed that the medical record data in the database represented TB and MDR-TB cases reported by all public healthcare facilities and private doctors practice offices within the city of Houston, and, therefore, generalizable to foreign-born TB population in Houston city and other jurisdictions with similar TB disease problems in the United States. Oren et al. (2011) studied TB problem in the largest 48 cities in the United States and recommended continuing investigations on challenges of urban TB in the United States. Texas and Houston represent the face of the demographic and racial diversity of the United States (U.S. Census, 2010), and was, therefore, an appropriate choice location for this study.

Scope and Delimitations

I focused in this study on the association between being infected with HIV, type of housing/residence, prevalence of TB and MDR-TB complications among foreign-born

populations in Houston. This specific focus is based on the fact that previous studies have shown high prevalence of TB among HIV patients (Myers & Sepkowitz, 2008; Young, Critchley, & Edwin, 2009), and an association between housing and prevalence of TB (LoBue, Cass, Lobo, Moser & Catanzaro, 1999). Prevalence of diabetes among TB patients in Texas is estimated at 39%, and diabetes contributes 25% of the TB cases, while HIV co-infection contributes about 5% (Restrepo et al., 2011). About 62.4% of the people living with HIV in Houston are homeless, while 19.4% are in jails (HDHHS, 2013b). And yet previous study effort documenting how these constructs affect prevalence of TB and MDR-TB complications among foreign-born populations in Houston is scarce.

The sampling frame included only database medical records for foreign-born TB patients who were diagnosed with TB 2 years after arrival in the United States and are or were receiving treatment for HIV/MDR-TB at healthcare facilities within Houston. Medical records of any patients not meeting this criteria were not eligible to take part in the study. The findings of this study will be generalizable to foreign-born populations living in Houston city and may be generalized with caution to immigrant communities living elsewhere in the United States.

Limitations of the Study

I captured information on foreign-born tuberculosis patients receiving treatment within the city of Houston healthcare facilities. It is possible that there could be such other TB patients receiving services in the neighboring countries, such as Mexico, and reside in Houston were captured in this study. There are also several potential intrinsic and extrinsic factors that were potential threats to internal and external validity of this

study, including: historical events that occurred during TB treatment that might have affected patients and influenced outcome variables, such as prior health education may influence MDR-TB among TB patients; differences in biological, psychological, and social processes, such as belief in personal efficacy in TB prevention may trigger psychological responses to bolster the immune system against development of MDR-TB; lack of access to complete information on TB and MDR-TB prevention may affect prevalence rate of and recovery from TB, or a combination of these factors may influence the incidence, and prevalence of TB and MDR-TB in a population . Differences in physiological development may influence the response to TB treatment such as differences in TB dose treatment responses between female and male TB patients (Sanneh & Pollock, 2010). Potential extrinsic factors may arise from the fact that participants eligible for inclusion in the study during the study period may not necessarily be eligible for another study period due to migration. For instance, an individual who received treatment for TB/MDR-TB and covered during the study period and no longer be residing within Houston Texas. This may lead to overestimation of the study findings. Use of secondary data may limit generalizability of the study.

Stratification of the study observations by country of origin minimized potential intrinsic and extrinsic factors that threatened the internal and external validity of the study, but inability to draw a random sample because of too few observation cases for some of the countries in this study undermined efforts to completely eliminate these threats. It was also important to work with the database archivist to ensure that only accurate, reliable, precise, unbiased, valid, and appropriate data were available for the study. The construct of validity was assured by using medical record data which has

previously shown 93% validity (Rudestam & Newton, 2007). Reliability of the TB field daily log and coding tool used by HDHHS field personnel for TB treatment follow-ups was neither subjected to Crobach's Alpha Test, (Field, 2009) nor used because during data retrieval it became clear that the log and the coding tool were disease management tools with no utility for the purpose of this study.

Significance of the Study

This study provided an opportunity to establish predictors of high TB and MDR-TB burden among foreign-born persons in the US in a setting of declining TB prevalence. A case study approach provides a means of inquiry for an in-depth examination of a phenomena (Stake, 1995; Yin, 1989). Yin (1989) states that the distinctive need for case study research arises from the desire to better understand complex social phenomena. Yin further argues that a single case design is warranted on the basis that the case is revelatory. A revelatory case study is one for which there is belief or assumption that the problems discovered in a particular case are common to others cases as well. Given that the incidence of TB and MDR-TB is a complex interplay of contextual influences, individual risk factors and their interrelationships , a case study is not only warranted, but the results of the findings may also apply to other jurisdictions experiencing similar TB disparities in the Unites States.

The first objective of the study was to increase knowledge of contextual factors that predict TB and MDR-TB prevalence among foreign-born populations. The second objective was to provide validated techniques to track rates of MDR-TB complications to prioritize risk factors targeted at these populations and for disease management programs. The findings of this study will, therefore, inform appropriate public health policy

interventions for the prevention, control of TB and MDR-TB, and reduction of TB morbidity, mortality and associated healthcare costs. These variables can also be measured for new patients and their values placed in a logistic regression model from which a probability of tuberculosis and MDR-TB complications could be estimated.

Summary

Tuberculosis is a significant public health problem globally and in the United States. Data indicate that while TB and MDR-TB prevalence rates have continued to decline among U.S.-born persons, they have, however, continued to increase among the foreign-born populations in the United States. The foreign-born populations are disproportionately affected by both TB and MDR-TB. In order to understand this phenomena, this study sought to examine the potential risk factors for TB and MDR-TB among foreign-born populations in Houston Texas as a case study with a focus on contextual influences, and a view of offering a framework for appropriate public health interventions for the prevention and control of TB and MDR-TB among foreign-born populations in the U.S. urban centers. The background, the health problem and the significance of this study stated in this chapter provided a logical framework for the exploration and critique of the current literature discussed in Chapter 2 that provide an evidence-based foundation for this study.

Chapter 2: Literature Review

In recent years TB has re-emerged as a major public health threat in the United States and internationally. The severity of the disease increased with the advent of HIV in the 1980s, and MDR-TB in the 1970s (El Sahly et al., 2006). More than 9 million new cases of, and 1.4 million deaths from, TB are reported each year worldwide (WHO, 2013a). A total of 9,951 new TB cases were reported in the United States in 2012, and 529 deaths from the disease were reported in 2011 (CDC, 2012a). In addition, 650,000 people are infected with MDR-TB globally (CDC, 2012a; WHO, 2013a).This trajectory continues and needs to be stopped.

The prevalence and incidence of TB is more severe in co-morbidity conditions. TB is associated with HIV and immune suppression. It is a serious risk factor and leading cause of morbidity and mortality among people living with HIV (El Sahly, Teeter, Pawlak, Musser, & Graviss, 2006). Furthermore, TB has taken a heavy toll on the U.S. economy, with an estimated annual total cost of $37.2 billion, which include $20.9 billion in direct health care costs, $7.4 billion in indirect morbidity costs, and $8.9 billion in indirect mortality costs(Miller & Washington, 2009; American Lung Association, 2008). Reduction of TB/co-morbidity should be an integral part in the TB/MDR-TB prevention strategy.

Despite efforts in the prevention and control of TB in the United States, foreign-born populations are still disproportionately affected by TB and MDR-TB. The TB prevalence rate among foreign-born persons is more than 11 times as high as in U.S.-born persons (CDC, 2012a). The TB disease burden is higher in large U.S. cities, where there is an average of 12.1 cases per 100,000 residents compared to a national average of 3.2

cases per 100,000 residents (CDC, 2012a; Oren, Winston, Pratt, Robison, & Narita, 2011). Houston has the highest TB prevalence rate of any city in Texas; it ranks third among all U.S. cities for prevalence of the disease (HDHHS, 2012). Although TB prevalence among U.S.-born persons in Houston has declined from 47.7% in 2009 to 42.1% in 2012, it increased from 51.1% to 57.9% among foreign-born persons over the same time period (HDHHS, 2012). Despite this increase, I could find no research has been conducted to explain this disparity.

The purpose of this study was to determine if an association exists between HIV infection with TB, type of housing/residence, and TB and MDR-TB prevalence among foreign-born persons in Houston. I wanted to examine whether these possible associations may explain the disparity in TB infection rates among foreign-born and U.S.-born persons in Houston city (Novignon & Nonvignon, 2012; Wu & Dalal, 2012)). Such knowledge, I believe, may inform appropriate strategies for continued awareness creation and surveillance of TB and MDR-TB among disproportionately affected communities. Initiatives to improve awareness, testing, and effective treatment of TB disease in foreign-born populations might facilitate progress towards the elimination of TB in the United States (Wilking, Hohle, Velasco, Suckau & Eckmanns, 2012).

In this chapter, I examined in detail gaps in existing knowledge on contextual and personal influences on TB infection through an in-depth review of the relevant literature. Evidence was gathered from previous studies conducted mainly within the United States. SEM was used to my SEM frame the discussion of multidimensional predictors of TB and complications of MDR-TB. Individual influences for TB infection and MDR-TB complication in model include age and gender; - contextual predictors, or external

influences, include co-morbidities such as (TB and HIV)- and housing type/residence. Most researchers studying this topic, (Dean and Fenton, 2011), have approached their studies from a multilevel perspective and have simultaneously assessed the influence of several of these factors on TB disease and MDR-TB complications. I sought literature review from the most appropriate and relevant study designs, assessments, and data analysis techniques in order to determine the most appropriate approach for investigating the interactions among these influences in the current study.

Literature Search Strategy

I searched the Thoreau, Science Direct, ProQuest, PubMed, Centers for Disease Control and Prevention, Institutes of Health, and the World Health Organization databases to find relevant research. I focused the literature search on studies based on the U.S. population because the research problem under investigation is U.S. specific, and many of the independent variables concern the epidemiology of infectious diseases and socio-economic issues in the United States. The keywords I used were TB co-infection with HIV, various terms for TB (e.g. tuberculosis disease, latent TB infection [LTBI], multidrug-resistant TB [MDR-TB], and TB incidence and prevalence), which I combined with phrases such as [“United States”, “Texas”, “Houston”, “Harris County”, “co-morbidity”, “type of housing/residence”, “homelessness”, “jail”, and “incarceration”]. Articles published after 2008 were given preference because they were more current. Using these criteria, I found 85 U.S.-specific articles, of which 32,concern TB and 10 concern MDR-TB (see Appendix B).

I organized the literature review into six sections. The first section provides a general overview of TB and MDR-TB in the U.S. including diagnosis, symptoms,

multidrug resistance, treatment, prevention, screening, control, and surveillance. The second section reviews previous studies related to the constructs of interest, and the third section examines studies that have evaluated risks for TB and MDR-TB complications. Studies relating to study designs are grouped into five categories: retrospective, population-based studies, cross-sectional, prospective cohort, case-control, and meta-analysis studies. The fourth section encompasses discussion of individual and contextual predictors of TB and MDR-TB in the United States. Limitations in design and analysis of previous studies and potential improvements are outlined in the fifth section. The last section summarizes significant findings from the literature and conclusions that are relevant to the foreign-born population in the U.S., and Houston, in particular.

Theoretical Foundation

SEM**,** which is also known as the ecological model, was employed in the design and conduct of this study. Social ecological model is a methodological framework used by researchers to examine the dynamic relationships between individuals and their social environment (Sallis, Owen, & Fisher, 2008). It is grounded in the biological sciences and ecology (Bronfenbrenner, 1994). According to Sallis, Owen, and Fisher (2008) and the World Health Organization (2013), the SEM framework proposes that health and behavior are influenced by multiple factors. SEM essentially takes into account the influences of environmental factors at multiple levels that shape individuals' behaviors and their susceptibility to disease (Sallis, Owen, & Fisher, 2008).

According to Sallis and Owen (as cited in Blanz, Rimer, & Viswanath, 2008) SEM focuses on multilevel of influence and posit that not only are health behaviors caused by multiple factors, but also that human beings, as for other organisms, cannot

exist in isolation, and instead operate in an interdependent network of relationships influenced by internal (individual) and external (environmental) factors (CDC, 2012c). The theoretical framework takes into account the environmental influences at multiple-layers, such as individual, family, community, and policy level factors, that help shape an individual's health behavior, and vulnerability to disease (Stokol, 1996). The SEM has found wide application in the United States, and elsewhere in the world, in the framing of disease prevention and health promotion programs.

The Institute of Medicine recognizes SEM as the principal theoretical framework for designing public health programs encompassing a multiplicity of stakeholders for the promotion of healthy communities in the United States (IOM, 2003b). The Healthy People 2020 health indicator targets are based on specific objectives that address the relationship between health status, biology, personal behavior, health sciences, social factors, and policies that emphasize an ecological approach to both individual and population level influences of health promotion interventions (HealthyPeople2020, 2013).

The Centers for Disease Control and Prevention has adopted SEM as the main framework for its health promotion programs, involving multiple bands of influence from individual, interpersonal, organizational, community and policy levels for the prevention and control of colorectal cancer (CDC, 2013c) and violence prevention (CDC, 2009c). The World Health Organization employed the SEM framework-based evidence to explain why some people or groups are at a higher risk of interpersonal violence, while others are more protected from it; where the SEM framework has been used to visualize interpersonal violence as the outcome of interaction among many factors at individual,

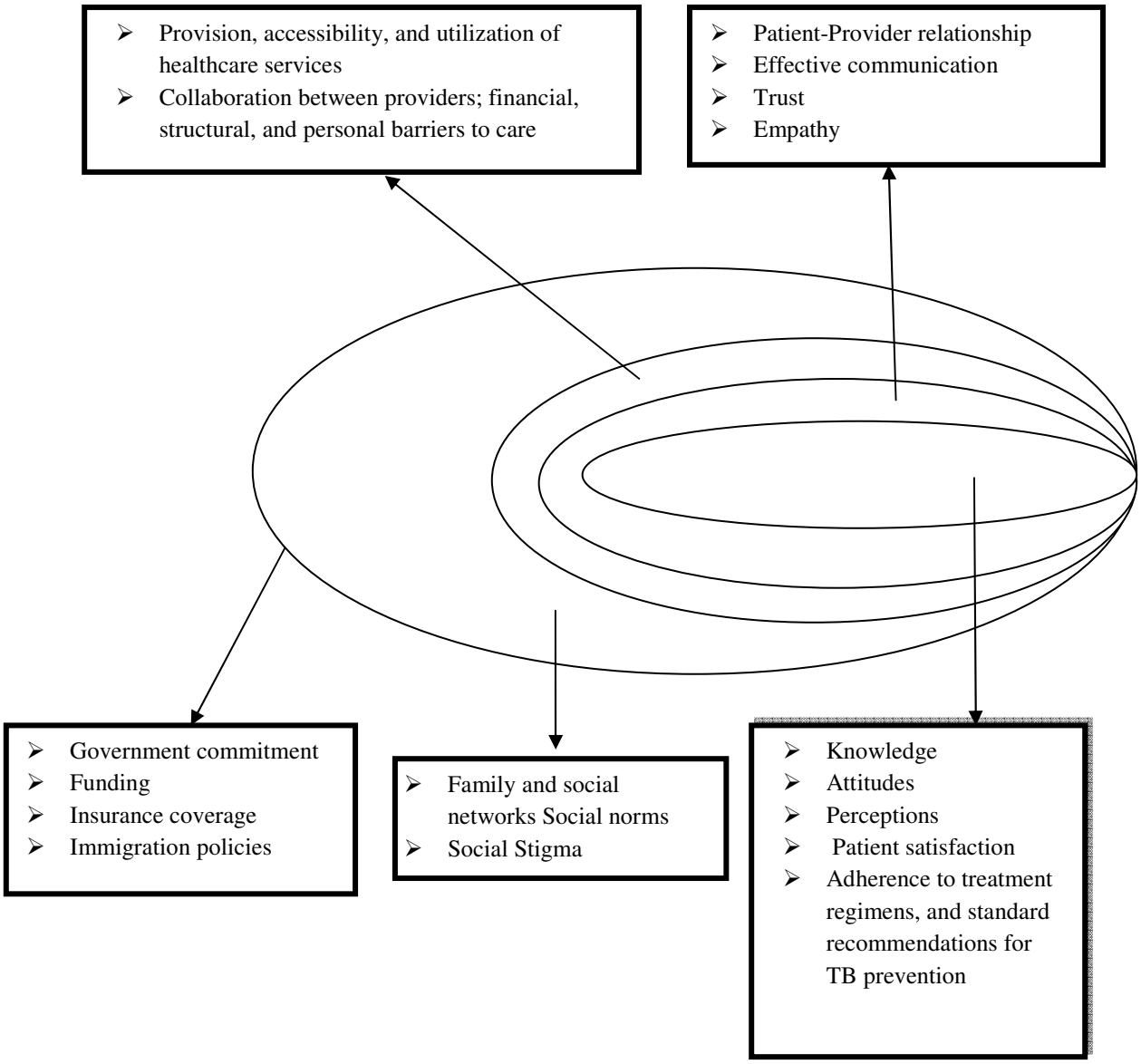
relationship, the community, and the societal levels (WHO, 2013b). Ali and Naylor (2013) used the same model to explain the phenomena of intimate partner violence. Fleury and Lee (2006) used the SEM to investigate social and contextual correlates (e.g. social norms, environment, social networks, and organizational support) influencing the adoption and maintenance of regular physical activity among minority and underserved populations in the United States. In the Wilking, Hohle, Velasco, Suckau and Eckmanns study (2012), SEM provided the theoretical framework to describe, in an ecological analysis, the impact of different social factors on the risk of acquiring infectious diseases, with particular reference to rotavirus infections in Berlin, Germany. Edberg, Clear, and Vyas (2011) assessed the diachronic interaction of ecological factors contributing to health disparities among immigrant/refugee populations using the SEM. Most recently, Li, and Rukavina (2012) utilized the SEM theoretical framework in studying the most effective strategies for inclusion of overweight or obese students in physical activities at schools. The ecological framework has been used to identify and implement ecological tobacco control programs in health promotion programs in Canada (Richard et al., 2004). The SEM provided a theory-based framework to characterize the nature and results of interventions conducted through larger public and private partnerships in the design of the Food Stamp Program for low-income populations in the United States (Gregson, Foerster, Orr, & Jones, 2001). Lee, Kim, and Lee (2010) used the SEM to study the impact of mass-produced public housing apartments on social exclusion, conflict, and social health promotion in the Republic of Korea. The ecological model has also been used as the theoretical framework to guide the study of interaction of individuals'

awareness, preferences, skills, and social environment in the influence of behavioral practices implicated in the transmission and prevention of HIV (de Wit & Adam, 2012).

The Socio-Ecological model has been used to depict the interactions of individual and contextual level factors in TB disease infection (CDC, 2012c). Tuberculosis as a social disease caused by airborne pathogens, that depends on human interaction within the community/household for its transmission. However, some communities provide ideal environment than others for the transmission to occur. These differences are partly explained by community/house-level ecological influences that facilitate TB transmission, such as poverty, overcrowding, lack of access to preventive healthcare, and other markers of deprivation that have long been associated with increased prevalence of TB. Because of its mode of transmission, social and economic cost to society, TB is one of the Notifiable diseases by local, state, and federal health departments (Myer, Westenhouse, Flood, & Riley, 2006). In addition to providing treatment to TB patients, health departments also collect case-specific demographic information, including age, gender, site of disease infection, country of origin, and drug-resistance. This focus on individual demographic data, however, neglects the ecological contexts of the disease occurrence. Information on community/household level and ecological risk factors for contracting TB and development of multidrug-resistant TB, are important for formulation of appropriate TB and MDR-TB prevention strategies. Because of the multi-level contexts of TB and MDR-TB occurrence, socio-ecological theoretical model was used to frame this study. The social ecological theory provides a logical framework for the epidemiological study of the TB and MDR-TB disparities among subpopulations, provide most appropriate framework for delineating variables to be studied and provide a good fit

to the data for this study. It permitted a unique opportunity to an understanding of the multilevel individual, social, and biophysical factors that predict prevalence of tuberculosis and multidrug-resistant tuberculosis among foreign-born populations in Houston as depicted in Figure 2. More specifically, behaviors are influenced by intrapersonal, interpersonal, social, and physical environmental factors. These multiple influences and their interactions are relevant for understanding health behaviors at individual, community, and organizational levels (CDC, 2012c) that may foster or prevent transmission of tuberculosis and development of multidrug-resistant tuberculosis among foreign-born populations in Houston.

Figure 2: Socio-Ecological Model: Individual and Environmental Risk Factors for TB



Intrapersonal level influences include knowledge, attitudes, and perception, patient satisfaction, and social stigma that affect individual behaviors of TB patients, such as health seeking behaviors, and adherence to treatment regimens. This level also addresses individual-level issues that may affect health-provider's behavior, such as adherence to guidelines, and standard recommendations for TB prevention and treatment. One of the most illustrative intrapersonal level provider-patient interrelationship from

the SEM perspective is the Direct Observation Therapy (DOT- core element of tuberculosis care and control measure where the health provider watches and ensures that the patients takes and swallows drugs as prescribed in TB and MDR-TB treatment and management. DOT leads to significant reductions in the frequency of primary TB drug resistance, acquired drug resistance, and lapses in tuberculosis treatment (Weis et al., 1994). Noncompliance with DOT is associated with increase in occurrence of poor TB treatment outcomes and accounts for most treatment failures (Burma et al., 1997). Ensuring universal DOT has been observed to improve TB treatment in Taiwan (Bloss et al., 2012). DOT has also shown to reduce the risk of drug resistance and provide treatment completion rates (Long, & Ellis, 2007). The underlying explanation of these associations is that better provider-patient relationship may lead to trust, resulting in adherence to the treatment regimen provide opportunities to detect drug side effects, or symptoms of complication for early remedial action.

Interpersonal dyadic level influences focus on relationship between a pair of individuals. Examples include patient-provider relationships and its impact on both the patient and provider as well as influences on family, significant other, or peer on patient. For example the innate characteristics of age and gender influence healthcare-seeking behavior. Dreek, Lombard, Michelmore, and Teede (2009), found that health screening behaviors are associated with gender and age. Men and women ≥ 51 years are more likely to have screening health checks than those ≤ 50 years. Women are more likely than men to nominate preparedness to have annual health checks, willingness to seek advice from their healthcare providers, and to attend health education sessions. Women ≥ 51 years and older, seek information regarding illness prevention than men and women ≤ 30 years

of age. While Cooper-Patrick et al. (1999), found that African American patients characterize their visits with physicians less participatory than whites. Improving cross-cultural communication between patients and health providers affects patient involvement in health decision making, levels of satisfaction, and better healthcare outcomes (van Servellen, 2009) Shortages of anti-TB drugs and the consequent adverse effects on the fight against TB and MDR-TB in the United States, has been extensively reported in the literature (e.g., Seaworth et al., 2013; Shah, Mase, Chorba & Castro, 2012; Warkentin et al., 2013).

Health system and organizations influences refer to multiple healthcare systems that foreign-born persons have to navigate to access healthcare services in Houston. Influences at this level include provision, accessibility, and utilization of healthcare services, and collaboration between providers for provision of integrated disease management services for comorbid cases. Access to healthcare is crucial in disease prevention and control, and refers to the degree to which individuals and groups are able to obtain appropriate healthcare from healthcare system in a timely manner (Morales, Lara, Kington, Valdez, & Escarce, 2002).Lack of access to healthcare is one of the leading causes of poor health outcomes (van Servellen, 2009) . Numerous studies have documented healthcare access disparities among members of minority populations due to a number of reasons, including financial, structural, and personal barriers to care. Financial barriers include inadequate or lack of health insurance, and low individual income. Structural barriers include organizational barriers to care and lack of transportation to and from healthcare givers. Personal barriers include cultural and linguistic factors (Morales et al., 2002). The Institute of Medicine's 2009 report:

America's Uninsured Crisis: Consequences for Health and Healthcare, points to a chasm between the health care needs of persons without insurance and access to effective healthcare services. This gap results in preventable illnesses, suffering, and even death (IOM, 2009) .

Community level influences affect behaviors at small group levels, such as family, and social networks. Examples include the influences of family and social network on individual relationship with local health services, social norms, and social stigma attached to TB , and hence their influence on healthcare seeking behavior. A well known example of health behavior influence at this level is the stigma and discrimination associated with TB among some cultures. Baral, Karki, and Newell (2007), found that TB is a highly stigmatized in Nepal with considerable discrimination against sufferers by the public and healthcare workers. They also found perceptions that TB was a divine punishment among some members of the public. Stigmatization and discrimination diminishes healthcare seeking behaviors, and constitutes an impediment to TB prevention efforts. The involvement of TB patients and communities in the design, planning, implementation, and evaluation of TB control initiatives is an important one in removing prejudices and discrimination, improving access to healthcare, and ensuring adherence to treatment regimens (Gargioni, 2009).

Policy level pertains to issues relating to government commitment to healthcare funding, health insurance coverage, and immigration policies that prevent the transmission of TB among foreign-born populations. For instance, most of the foreign-born persons (except for children) in Houston are allowed to access Medicaid for the first six months on arrival in the US for their healthcare needs, after which they are

expected to make their own arrangements for healthcare. In an environment of scarce job opportunities, this policy is likely to crowd-out unemployed persons from the healthcare system, and adversely affect their health and well-being.

Although most of the researchers did not refer to any specific conceptual framework in their inquiry, many researchers, however, inferred the applicability of the SEM by approaching their investigations from multilevel perspectives encompassing intrapersonal, interpersonal, environmental, and community factors of influence. For example, Pratt, Winston, Kammerer, and Amstrong (2008) analysis of National Tuberculosis Surveillance System (NTBSS) data (1993-2008), determined that age (individual factor), homelessness (community or social relations), HIV co-infection (healthcare system intervention), and substance abuse (failure of health policy), were predictors of TB disease infection. Previous studies have cited the socio-ecological model as an appropriate conceptual framework for the prevention and control of both infectious and non-communicable diseases (WHO, 2013).

Cargo et al. (2011) in a longitudinal assessment of the impact of integration of an ecological approach into Aboriginal community-based cardiovascular disease (CVD) and type 2 diabetes program, determined that utilization of ecological approach would significantly prevent both disease conditions, and will be facilitated by greater inter-organizational collaboration and centralized planning, because upfront time required for community stakeholders to develop capacity to mobilize for the chronic and infectious diseases, was at odds with short-time funding cycles that emphasize organizational accountability.

Other researchers have established that TB co-morbidity with HIV and diabetes present unique challenges for TB prevention and control. Dean and Fenton (2011), examined this phenomenon and determined that implementing an ecological approach that improves program collaboration, and service integration; investing in economic interventions (e.g., microfinance); examining opportunities for aggressive policy and legislative initiatives that change the context for disease prevention; shifting prevention programs to include more diverse portfolio of prevention approaches that include individual-, network-, and community-level interventions; and, investing in research to understand and address the social and structural barriers to disease prevention and control, is critical disease and MDR-TB prevention and control programs. Balcaza et al. (2012), found that multilevel ecological approach was the most effective framework for addressing cardiovascular disease risk factors among Hispanics on the U.S.-Mexico border by moving from a clinical care model to a community model of prevention through a comprehensive community engagement.

Diverse theories and models support and provide understanding of the framework of quantitative studies. Although SEM is an overarching theoretical framework, it does not, however, preclude the use of other mid-level theories. Other major health behavior models include Health Belief Model, Theory of Reasoned Action/Planned Behavior, Social Cognitive Theory (SCT), and the Trans-theoretical Model. However, different theories explain the same phenomena differently (Redding, Rossi, Rossi, Wayne, & Prochaska, 2000). The ultimate goal of disease prevention is to stop adverse health outcomes from happening. Effective TB and MDR-TB prevention and control strategies among foreign-born populations in Houston, require an understanding of the factors

influencing TB and MDR-TB occurrence among these populations. The socio-ecological model of TB and MDR-TB prevention attempts in reaching this understanding (CDC, 2009c; McLeroy, Steckler, Bibeau & Blanz, 1988; University of Oregon, 2013). While historically, epidemiological studies have focused on intrapersonal level health risk factors , the future demands a comprehensive approach to epidemiological data characterizing multiple-level influences of TB and MDT-TB prevention and control (Baral, Logie, Grosso, Wirtz,& Beyrer, 2013; CDC, 2012b). In this study, I sought to assess multiple factors that influence prevalence of TB and MDR-TB complication among foreign-born populations in Houston, and more specifically addressed the research questions if being infected with HIV and type of housing/residence are associated with prevalence of TB and MDR-TB complication among foreign-born populations in Houston. Because significant and dynamic interrelationships exist among different levels of health influences for TB and MDR-TB, public health interventions are most likely to be more effective when they address these influences at all levels simultaneously.

Latent TB infection Vs. TB Disease

Tuberculosis is a bacterial disease caused by the bacterium *Mycobacterium tuberculosis* (CDC, 2013a). Also known as Koch's bacillus, the small, rod shaped bacterium was discovered by Dr. Robert Koch in 1882 (Butler & Carr, 2013). The bacterium is found only in people and not in other living organisms and requires oxygen to survive (Butler & Carr, 2013). The bacteria are air borne and spread from person to person when an infected person, for example, coughs, sneezes, speaks, laughs, or sings. People nearby breathe in these bacteria and become infected. The disease usually attacks

the lungs, but can attack any part of the body including the kidneys, spine and brain. TB disease is fatal if not properly treated (CDC, 2013c).

Latent TB Infection

Not all people infected with TB bacteria become sick, giving rise to the existence of two TB-related conditions: Latent and TB disease. TB bacteria can live in the body without making the host sick, and this is known as the latent TB infection [LTBI] (CDC, 2013d; NIH, 2012a). In most cases, people who are infected, their body immune system is able to fight off the bacteria and stop them from growing and developing into active TB disease. People with latent TB infection do not feel sick, show no symptoms, and cannot spread TB bacteria to other people. However, the TB bacteria become active when there is a congruence of factors that promote the growth, and multiplication of the bacteria, and the infected person develop a fully blown TB disease (CDC, 2013d; NIH, 2012b).

TB Disease

TB bacteria become active, grow, and multiply into TB disease if, for example the immune system is suppressed. Many people with latent infection never develop TB disease; some develop TB disease soon after becoming infected (within weeks) (NIH, 2012c). Other people succumb to the disease years later when their immune system is weak through a convergence of influences, including the interaction of environmental and personal factors. A person infected with TB bacteria has higher risk for developing TB disease if: has HIV infection; has recently been infected with TB bacteria (in the last 2 years); has other disease (co-infections such as HIV and diabetes that suppress the

immune system); has drug abuse problem; or not properly treated for previous TB infections (CDC, 2013d; NIH, 2012c).

Symptoms

Early symptoms of active TB may present in weight loss, fever, night sweats, and loss of appetite. For some people, the symptoms may be more subtle, and may go unnoticed, while in others the disease either goes into remission or become more chronic and debilitating with cough, chest pain, and bloody sputum (NIH, 2012d).

Diagnosis

Initial diagnosis is by tuberculin skin test (injection of tuberculin [purified protein derivative] under the skin of the forearm) (NIH, 2012 e). If a red welt forms around the injection site within 72 hours, then the person may have been infected. However, this is not conclusive evidence of the presence of active TB disease and may require further evaluation. People who may test positive on the tuberculin skin test include people with previous exposure to *Mycobacterium tuberculosis* (NIH, 2012e).

Treatment

People with LTBI have TB bacteria in their bodies, but are not infectious, and cannot spread the disease (NIH, 2012a). However, the bacteria may become active and multiply causing TB disease. For this reason, people with LTBI must be prescribed treatment to prevent them developing active TB disease. Treatment of latent and TB infections are essential in TB control and prevention programs (CDC, 2012c; NIH, 2012f). Current CDC guidelines recommend screening and treatment for latent TB infection for immigrants and refugees within five year of arrival in the US (Page et al., 2008). Medications for treatment of LTBI include: isoniazid (INH), rifampin (RIF), and

rifapentine (RPT). People with compromised immune system are at high risk of developing TB and require immediate and appropriate treatment and ensure completion of the entire course of treatment (CDC, 2012c).

Treatment of TB disease require along treatment course taking several drugs for 6 to 9 months. The first-line drugs for the treatment of TB approved by the Food and Drug Administration include: isoniazid, rifampin, ethambutol (EMB), pyrazinamide (PZA). It is important that people with TB disease complete the prescribed treatment regimens to avoid developing drug resistant TB which takes a long time and costlier to treat, and sometimes fatal (CDC, 2012c).

Since 1993, the World Health Organization (WHO, 2006) has embraced Directly Observed Therapy, Short Course (DOTS) as the standard TB patient care through which governments of the WHO member countries meet their responsibilities in treating TB patients and preventing the spread of tuberculosis (WHO, 2006). Under DOTS protocol, health providers watch their patients swallow every dose of the prescribed TB drug. The strategy is a component of case management that helps to ensure that TB patients adhere to recommended treatment regimens. It is the most effective strategy for making sure that patients take their medicine as prescribed. DOTS should be considered for all TB patients because it is difficult to predict non-adherence, and every DOTS visit should be recorded by the healthcare provider (WHO, 2006).

DOTS is the pivotal part of the WHO Stop TB Strategy (WHO, 2013a), which espouses five basic components for TB prevention including: political commitment by WHO member states for an increased and sustained financing of TB programs; case detection through quality-assured bacteriology (sputum smear microscopy); standardized

treatment with supervision and patient support by healthcare worker or community health worker; an effective drug supply and management system (WHO, 2006). The United States Government supports the Stop TB Strategy through the President's Emergency Plan for Global Relief (PEPFAR) to help fight AIDS, malaria, and tuberculosis worldwide (Kaiser Family Foundation, 2013). PEPFAR was authorized by the United States Leadership Against HIV/AIDS, Tuberculosis and Malaria Act of 2003(P.L 108-25), a five year rolling multibillion dollar initiative to combat global HIV/AIDS and TB, primarily in 15 hard hit focus countries, and makes multilateral contribution to Global Fund to fight HIV/AIDS, tuberculosis and malaria(Kaiser Family Foundation, 2013).

Multidrug-resistant TB

Multidrug-resistant TB (MDR-TB) is due to TB bacterium that is resistant to at least isoniazid and rifampin, the two most effective TB drugs (CDC, 2012c). Extensively drug resistant TB (XDR-TB) is a rare type of MDR-TB that is resistant to isoniazid and rifampin in addition to fluoroquinolone and at least of three injectable second-line drugs(i.e., amikacin, kanamycin, or capreomycin) (CDC, 2012c). Because XDR-TB is resistant to most effective TB drugs, patients are left with far too fewer treatment options that are much less effective. Resistance to anti-TB drugs occur when drugs are either misused or mismanaged, for example when patients do not complete full course of treatment, when healthcare providers prescribe wrong treatment, wrong dosage, wrong treatment periods, or when supply of drugs is irregular, or drugs are of poor quality (NIH, 2012f).

The WHO estimated that there were 650,000 cases of MDR-TB worldwide in 2010 (WHO, 2012). The emergence of drug-resistant forms of TB, which was uncommon

20 years ago (Abubakar et al., 2013; Andrew et al. (2010) presents a major challenge to healthcare community globally and in the United States. In addition, the strains of XDR-TB also continue to emerge. It costs approximately $483,000 to treat one case of XDR-TB in hospital, and about 50% of this amount to treat one case of MDR-TB in the United States (Abubakar et al., 2013; CDC, 2010b). Pooran, Pieterson, Davids, Theron, and Dheda (2013) conducted a study to determine the cost of treating MDR-TB in the republic of South Africa by analyzing the comparative 2011 US dollar ($) cost of diagnosis and treatment of drug-sensitive TB (DS-TB), MDR-TB and XDR-TB, based on the National South African Guidelines. They found that the cost of XDR-TB was $26,392 per person, four times greater than MDR-TB ($6,772), and 103 times greater than drug-sensitive TB ($257). Despite MDR-TB comprising only 2.2% of the case burden, the researchers found that MDR-TB consumed 32% of the 2011 estimated national TB budget of $218 million (Pooran et al.,2013) (citation). Anti-drug and hospitalization costs accounted for 45% and 25% of these costs, respectively. XDR-TB consumed 28% of the MDR-TB diagnosis and treatment costs. Laboratory testing and anti-drugs comprised majority (71%) of MDR-TB costs, while hospitalization and anti-TB drug costs comprised majority (92%) of XDR-TB costs (Pooran et al., 2013).

Although multidrug-resistant TB inflict high mortality rates, difficult and costly to treat, cure may be possible with right combination and rational use of approved anti-tuberculosis drugs (NIH, 2012f). The recommended regimen is the combination of at least four drugs to which the *M. tuberculosis* isolate is susceptible. Drugs are chosen with a stepwise selection process through five groups on the basis of efficacy, safety, and cost (NIH, 2012f). The first group high-dose isoniazid, pyrazinamide and ethambutol are

thought of an adjunct for the treatment of MDR-TB and XDR-TB. The second group comprise of fluoroquinolones, of which high-dose levofloxacin is preferable. The third group included the injectable drugs recommended in the following order: capreomycin, kanamycin, and amikacin. The second-line TB drugs constitute the fourth group, used in the following recommended order: thioamides, cycloserine, and aminosalicyclic acid. The fifth group includes drugs whose efficacy is not yet fully determined and include: clofazimine, amoxicillin with clavulanate, linezolid, carbapenems, thioacetazone, and clarithromycin (NIH, 2012f).

Prevention

Since TB is air borne, transmission can be prevented through adequate ventilation and limited contact with infected people (NIH, 2012b).People in high risk groups, such as HIV patients and diabetics, can be treated with medicine to prevent reactivation of latent TB. In 1993 the WHO, launched Stop TB Worldwide Strategy (WHO, 2004) which builds on the success of DOTS, while also addressing key challenges facing TB prevention. The overarching goal of the Stop TB Strategy is to reduce the global TB burden by 50% relative to 1993 baseline figures by 2015 by ensuring that TB patients including those co-infected with HIV and those with drug-resistant TB benefit from universal access to high-quality diagnosis and patient-centered treatment (WHO, 2013b). The strategy also supports development of new effective tools to prevent, detect, and treat TB. The Stop TB Strategy underpins the Stop TB Partnership's Global Plan to Stop TB 2006-2015 (WHO, 2013b). Prevention of MDR-TB is through adherence and compliance with the recommended treatment regimens. Avoidance to exposure to known MDR-TB patients in closed or crowded places such as healthcare facilities, prisons, crowded

houses, or homeless shelters is a sound prevention strategy. Additional preventive measures include using personal respirators and protective devices (NIH, 2012b). Integrated disease management approaches of diseases known to suppress immune response, such as HIV and diabetes with TB, will help early detection and treatment of TB (NIH, 2012f).

In other parts of the world where TB is endemic, the World Health Organization recommends that infants (≤ 2 year of age) receive Bacille- Calmette-Gue'rin (BCG) vaccine (WHO, 2012). BCG vaccine does not protect adults effectively against lung TB which is easiest to spread to other people (NIH, 2012).The BCG vaccine is not currently recommended for infants in the United States, because of side effects and is relatively ineffective (CDC, 2012b).

Screening and Control

The Centers for Disease Control and Prevention work with physicians to provide specific instructions for medical care of refugees before their resettlement in the United States. These specific directives (called Technical Instructions) focus on the medical screening of refugees and immigrants for tuberculosis in accordance with U.S. immigration law (CDC, 2009b).The technical instructions are meant for panel physicians-who perform overseas screening, and civil surgeons who handle immigrants and refugees medical screening for resettlement in the United States. The Technical Instructions were updated in 2010 (Mazurek et al., 2010). From October 1, 2013 panel physicians in all countries were required to use complete Cultures and Directly Observed Therapy (DOT) Tuberculosis Technical Instructions (CDOT TB TIS).

A complete overseas medical screening examination for TB cover medical history, physical examination, chest radiography (CXR, when required), determination of immune response to *M. tuberculosis* antigen (i.e., tuberculin Skin Testing [TST] or interferon gamma release assay [IGRA], when required), and sputum testing for *M.tuberculosis* (CDC, 2009b). Applicants ≥ 15 years of age require medical history, physical examination, and CXR. Applicants 2-14 years of age living in countries with a WHO-estimated tuberculosis incidence rate of ≥ 20 cases/100,000 population should have TST or IGRA. All applicants ≤ 2 years of age living in countries with a WHO-estimated tuberculosis incidence rate ≥ 20 cases/100,000 population must have a physical examination, and history provided by the parent or guardian (CDC, 2009b). Once the immigrants and refugees arrive in the US, the Centers for Disease Control and Prevention recommend that they receive a follow-up evaluation (domestic medical screening) within 30 days after arrival (CDC, 2009b). Components of immigrants and refugees domestic health assessment for TB include review of all overseas health records including chest radiography, complete history and physical examinations, and clinical evaluation for TB (CDC, 2009b).

To control the spread of TB, healthcare facilities are expected to take precautions to prevent spread of TB including identification of persons suspected of TB, and using ultraviolet light to sterilize air, special filters, respirators and masks. TB patients should be isolated in special rooms with controlled ventilation and airflows until they are no longer considered infectious (NIH, 2012b). In response to resurgence of TB disease in the mid-1980s and early 1990s, observed increasing prevalence of TB among HIV co-infected persons, lapses in infection-control practices, delays in diagnosis and treatment

of persons with infectious TB disease, and appearance of multidrug-resistant TB, the CDC issued guidelines for preventing transmission of TB bacteria in all healthcare settings that include any facility that provides healthcare, such as hospitals, clinics, homecare, and detention facilities (CDC, 2009b). The guidelines, among other things, required that every healthcare setting to have a written TB-infection control plan, TB risk assessment plan, TB screening risk classification, continuous training and education for all persons working in the healthcare setting who may be exposed to *M. tuberculosis* through air space shared with persons with infectious TB, putting such workers under a TB surveillance program, and requiring that such persons receive baseline TB screening upon first hire (CDC, 2005).

Approximately 950,000 international travelers arrive in the United States daily (Kim et al., 2012). The Secretary to U.S. Department of Health and Human Services is authorized by law to prevent the introduction, transmission, and spread of communicable diseases by travelers into and within the country (Kim et al., 2012). The Secretary through the CDC Director, delegates this authority to CDC' Division of Global Migration and Quarantine (DGMQ). TB is one of the communicable diseases for which federal quarantine and isolation are authorized by Executive Orders of the President at major U.S. ports of entry to contain spread of TB disease into the United States by international travelers.

Surveillance

The National TB Surveillance System (NTBSS) Reports contain tabular and graphic information about reported TB cases collected from 59 reporting areas in the US (the 50 states, the District of Columbia, New York City, U.S. dependencies and

possessions, and independent nations in free association with the United States) (CDC, 2013g). The NTBSS reports include statistics on tuberculosis case counts and case rates by state and metropolitan statistical areas with tables of selected demographic and clinical characteristics (e.g., race/ethnicity, age group, country of origin, form of disease, and drug resistance) (CDC, 2013g). In Texas annual surveillance reports are generated by the State Department of Health Services (DSHS), Tuberculosis Branch, by compiling and analyzing tuberculosis screening activities from correctional and healthcare facilities that meet Texas Health Safety Code chapter 89 criteria. The screening activities include tuberculin skin tests, chest x-rays, number of suspected and confirmed cases by race/ethnicity, age, country of origin, form of disease, and drug resistance before forwarding consolidated surveillance report to the Centers for Disease Control and Prevention (DSHS,2013)

Prevalence of TB Disease

TB Disease in the United States

One-third of the world population is infected with TB (CDC, 2013a). In 2011, 9 million people became sick with TB, and 1.4 million died worldwide. TB is a leading cause of death of people co-infected with human immunodeficiency virus (HIV) (CDC, 2013a). A total of 9,945 TB cases (a rate of 3.2/100,000 population) were reported in the United States in 2012 (CDC, 2013b). This represented 5.4% of TB cases reported and 6.1% case rate decline compared with 2011 respectively. Appendix A, TableA1 depicts the TB incidence in the United States since 1953 to 2012 (CDC, 2013b). Tables A2 - A3 show TB trends in the US, and the State of Texas compared to Houston between 2009

and 2012, while table A4 shows TB incidence rates among U.S.-born and foreign-born persons in Houston between 2009 and 2012.

The number of TB cases reported in the United States declined from 84,304 in 1953, when the TB reporting system started, to 9,945 in 2012, while the case rate declined from 52.6/100, 000 population to 3.2/100,000 over the same time period (CDC, 2013b). A total of 569 new deaths from TB were reported in 2010, and 529 in 2011, compared to 776 deaths that were reported in 2000 (CDC, 2013b). Behind this impressive achievement, however, underlies glaring TB disease burden disparities among the U.S.-born persons on one hand, and between U.S.-born and foreign-born persons on the other. Kemper (2012) found that new TB cases declined by 3.8% in 2011 in the U.S. The Asian-American population was the largest ethnic group affected by TB.

Half of the national TB cases occurred in four states in 2011: California, Florida, New York, and Texas (Kemper, 2012). Certain subgroups are disproportionately affected by TB, and tuberculosis cases and case rates differ by demographic factors such as age, sex, race/ethnicity, and country of origin. TB case rates generally increase as age increases; males are 62% more likely than females to have TB (American Lung Association, 2013); minority populations accounted for 83% of TB cases in 2011 and; during the same time period more than 62% of TB cases occurred among foreign-born persons (American Lung Association, 2013).These factors may favor high TB prevalence in the four states. For instance, the states reported with the largest number of old populations in 2010 were California, Florida, New York, and Texas in that order, while the states with the highest number of foreign-born population during the same time period were California, Texas, Florida, and New York in that order (U.S. Census, 2010).

Nahid et al., (2011) found a steady increase since 2000, in TB cases recorded among foreign-born persons as cases in U.S.-born individuals continued to drop. Of the 4,378 cases of TB reported among U.S.-born persons in 2010, 40% were among non-Hispanic blacks, 8 times higher than among non-Hispanic whites (Nahid et al., 2011). Similarly, 63% of the reported TB cases in 2012 occurred among foreign-born persons. The TB case rate among foreign-born persons in 2012 was 15.6 cases/100,000 population, approximately 11 times higher than among U.S.-born persons (1.4 cases/100,000 population) (CDC, 2012a). Menzie, Winston, Holtz, Cain, and Kenzie (2010) examined trends in TB case and case rate among U.S.-born and foreign-born children and adolescents using the National Tuberculosis System (NTBSS) data for 1994 to 2007, and found that foreign-born children and adolescent accounted for 31% of 18,659 reported TB cases in persons ≤ 18 years of age. They further found that TB rates declined 44% among foreign-born children and adolescents (20.3/100,000 to 11.4/100,000 population), and 48%% (2.1/100,000 to 1.1/100,000 population) for U.S.-born children and adolescents. TB rates were nearly 20 times as high among foreign-born as among U.S.-born children and adolescents.

TB Disease in Texas and Houston

Of the 1,233 TB cases reported in Texas (a case rate of 4.7/100,000) in 2012, 195 (out of 267 in Harris County [Table A3]) occurred in Houston (HDHHS, 2013). Texas State was fourth with the highest number of TB cases of any state after California, Hawaii, and New York, while Houston was first with the highest TB cases of any city in Texas, and third nationally (HDHHS, 2013; TSDHS, 2013). Feske, Teeter, Musser, and Graviss (2011) using surveillance data to assess the spatial distribution of TB cases,

analysis revealed that there are neighborhoods within Houston/ Harris County that had heavy TB burden with yearly incidence rates that varied from 245/100,000 – 754/100,000 which was not exclusively dependent of the number of cases reported. To achieve the TB elimination goals stated by the Healthy People 2020 (HP, 2012), the Institute of Medicine (IOM 2003b), and the Centers for Disease Control and Prevention (CDC 2012b), requires measures to speed the currently stagnant TB elimination rate and curtail a future peak in TB incidence in the Unites States (Feske et al., 2011). Effective TB elimination strategies will involve the geographical elucidation of TB endemic areas within the US, and systematic surveillance of the locations and location-based risk factors associated with TB transmission which is currently not well understood for Houston (Feske, et al., 2011). For instance, Texas State Department classify being foreign-born as a risk factor for TB (figure 2). But no specific contextual or individual risk factors influencing high TB disparity among foreign-born persons have been elucidated. Interaction among contextual and individual risk factors create unique epidemiological risk factor pathways for contracting TB by foreign-born residents in the US, complicating the magnitude and severity of TB and public health efforts to control TB.

Studies Related to the Variables of Interest

TB and HIV Co -morbidity

In the decades preceding 1980, rates of tuberculosis declined globally. With the advent of the human immunodeficiency virus (HIV) in the 1980s, however, rates in many countries have dramatically increased (Myers & Sepkowitz, 2008). The two epidemics are now catastrophically intertwined. Overall, an estimated 80% of new TB cases are attributable to HIV co-infection (WHO, 2008). The HIV pandemic is one of greatest

challenges facing TB control programs. Aoron et al. (2004) in apopulation-based study determined that body immune suppression brought about by HIV infection increases the risk of reactivation of latent TB infection and rapid progression to active TB disease.

Gao, Zheng, and Fu (2013) in a study to determine the prevalence of TB and HIV co-infection worldwide, using meta-analysis based on systematic review of published articles, found that estimates of TB/HIV co-infection prevalence ranged from 2.93% to 72.34%. Prevalence of TB/HIV co-infection was 31.25% (95%Cl 19.30 - 43.17) in African countries, 17.21% (95%Cl 9.95 - 24.46) in Asian countries, 20.11% (95%Cl 13.2 – 26.39) in European countries, 25.06% (95%Cl 19.25 – 30.84) in Latin American countries, and 14.84% (95%Cl 10.44 – 19.24) in the USA. Prevalence of TB/HIV co-infection was higher in studies in which TB diagnosed by chest X-rays and HIV diagnosed based on blood analyses compared to those that used other diagnostic methods, and in countries with higher prevalence HIV in the general population than in countries with lower general prevalence.

Valadas et al. (2013) sought to determine the prevalence TB/HIV/Malaria co-infection in a retrospective study from demographic, diagnostic, and clinical data analysis from 4,666 patients admitted during 2007 at the Hospital Sanatorio de Luanda, of whom 1,906 (40.8%) were diagnosed with TB. Overall, 1,111 patients (58.3%) were male and most patients (68.2%, [n = 1302]), were adults. The researchers determined that the rate of TB/HIV co-infection was 37.4% (n = 712), and overall mortality was 15.2% (n = 290). The researchers found that it was problematic to perform culture-based diagnosis of TB for lack of appropriate infrastructure in Luanda.

Rajam and Muhammad (2013) conducted a retrospective study to determine the HIV prevalence among patients with pulmonary tuberculosis at a private medical College Hospital, Coimbatore, India. The researchers retrieved records of 324 pulmonary TB patients admitted over one year period from July, 2009 – June, 2010. Data for sociodemographic characteristics, sputum status, details about HIV screening, HIV status, and treatment regimens were collected and analyzed. The researchers found that 8.6% (16/186) of the patients who were diagnosed with pulmonary TB were HIV-1 seropositive. Most HIV-positive patients with tuberculosis were males (87.5%) and prevalence of HIV co-infection among patients with tuberculosis was highest in patients aged 33 – 48 years. The researchers recommended for compulsory HIV screening among pulmonary TB cases, and sputum testing among HIV patients for early detection and treatment to reduce morbidity and mortality from TB/HIV co-infection (Rajam & Muhammad, 2013).

Metcalfe et al. (2013) cross-matched incident TB cases reported to state surveillance systems during 1993 – 2006 with cases in the state HIV/AIDS registry to assess the state epidemiology of tuberculosis and HIV co-infection in California. The researchers determined that patients co-infected with TB/HIV during 2001 – 2008 were significantly more likely than those infected before highly active antiretroviral therapy became available to be foreign-born, Hispanic, or Asian/Pacific Islanders and have pyrazinamidemono-resistant TB. Mortality rate decreased after highly active antiretroviral therapy became available, but remained twice that for TB patients without HIV infection and higher for women.

De Lourdes et al.(2009) analyzed the epidemiological indicators of TB/HIV co-infection in Sao Paulo, Brazil from 1998 – 2006 using data obtained from the TB Notification System(EPI-TB) on 306 cases, and found an incidence rate of 5.1/100,000 inhabitants in 2006. Most cases were men (72.5%) with ages ranging between 20 and 59 years (94.4%). The majority had incomplete primary education. Pulmonary TB was the most common type (52.9%) and 46.1% of the patients received supervised treatment. In 2006, the cure rate was 33.34%, 14.3% death rate and no patient was lost to follow (citation). Diagnosis occurred in the hospital in 69% of the cases. The researchers showed the need for improved coordination between the TB control program and the sexually transmitted diseases and HIV program.

TB and Diabetes Co-infection

Diabetes mellitus is one of the recognized risk factors for TB (Kibirige, Ssekitoleko, Mutebi, & Worodria, 2013). Young, Critchley, and Edwin (2009) observed that the association between diabetes mellitus and TB can be found as far back as 1000 AD when Avicenna noted that “phthisis”, (a Greek term for tuberculosis), complicated incidence of diabetes and that the presence of diabetes resulted in an increased risk for developing TB (Hossain, Kawar, & El Nahas, 2007). TB and diabetes co-morbidity is likely to become even more critical in the future, as the prevalence of obesity and diabetes are expected to rise dramatically in poor-settings where TB also thrives (Hossain, Kawar, & El Nahas, 2007).

In 2011, the WHO and International Union-Against Tuberculosis and Lung Disease released a report acknowledging the association between TB and diabetes, and called for increased collaboration between TB and diabetes control efforts (Kibirige et al.,

2013). Sullivan and Ben (2012) also found a strong evidence for a link between TB and diabetes. Patients with diabetes were at increased risk of developing active TB, and had higher rates of treatment failure and death, even when placed on appropriate TB treatment.

Jeon and Murray (2008) in a systemic review of 13 observational studies, found that having diabetes was associated with an overall relative risk (RR) of 3.11 for contracting TB. Stevenson et al. (2007), in as systemic review reporting on the association of TB and diabetes, found 9 studies in which diabetes was estimated to increase the risk of TB infection from 1.5 to 7.8 fold, and further found that the relative risk for contracting TB among individuals with diabetes mellitus varied by age, being highest in younger groups. Several other studies have evaluated the association between diabetes mellitus (DM) and tuberculosis and posit that TB incidence may be influenced by immunosuppression by diabetes mellitus, but this relationship may be confounded by other clinical and socio-economic factors (Reis-Santos et al., 2013). Diabetes also influence TB severity and treatment outcomes (Reed et al., 2013). Bakeret al.(2011) also found a relative risk of death of 1.89 among TB patients with diabetes compared to non-diabetic TB patients. After controlling for potential confounders, the pooled risk of death among TB-diabetic patients increased five times compared to non-diabetic TB patients.

Type of Housing and TB

Housing is meant to provide shelter and security and considered a fundamental development process, in which the built environment is created, used, and maintained for physical, social, and quality of life of individuals and populations (Lawrence, 2004). Garcia (2004) found linkages between poverty, crowded housing, and contact with

immigrants with high incidence of TB among American-born persons . Davies (2005) found an association between HIV/AIDS, genetics, where people live and work and TB infection. Marsh, Gordon, Heslop, & Pantazis(2000) , and Northridge, Ramirez, Stingone and Claudo (2010) found evidence linking housing and health status.. The 1990 Report by Health Canada's First Nationals and Inuit Health Branch, which dealt with tuberculosis in the First Nations, identified housing density as a major factor in the TB prevalence (Toronto Star: May, 16, 2006). The authors posit that crowded housing, dearth of sanitation, and lack of running water are breeding grounds for TB infections, and claim that eradicating TB means eliminating conditions that breed it, and that war against TB should begin at home. Gender inequalities are also strongly interrelated with inequalities in shelter. Gender inequalities can determine who owns or controls housing, how domestic spaces are utilized, quality, location and accessibility of housing (Chant, 2012). These inequalities disproportionately affect women and often at most marked in the context of urban poor housing settings (Chant, 2012).

Moreau et al. (2012) determined the transmission dynamics of TB in a large urban apartment building and three homeless shelters within one-block radius in Edmonton, Alberta, in a multiethnic multicenter inner-city TB outbreak. Patient charts between 2008 and 2009 were reviewed through the integrated Public Health information System (iPHS) to extract demographic, clinical, and treatment data as well as data for contacts for 19 cases involved in the outbreak. The researchers determined the transmission of a novel TB strain from foreign-born populations to Canadian-born populations through under- housed settings serving vulnerable populations, highlighting changing demographics and emerging health concerns among under-housed populations.

LoBue, Cass, Lobo, Moser, and Catanzaro (1999) study objective was to determine experience with a novel supervised housing program to aid the treatment of TB among homeless persons in San Diego county TB control program. Database was used to identify homeless individuals placed in two supervised housing treatment for TB (Young Men's Christian Association [YMCA]) for noninfectious patients, or Bissell House, for infectious patients. Charts of the patients were reviewed and information regarding their demographics, underlying medical conditions, therapy, microbiologic markers of response to therapy, hospitalizations, and participation in supervised housing program were recorded. The researchers determined that the sputum culture conversion and treatment completion rates for those housed in the YMCA were 100 and 84.6% respectively. Of the patients in Bissell House, 100% had converted their smear and culture. All patients in the program completed a course of supervised therapy. The researchers concluded that the use of supervised housing to aid in treatment of TB was effective among the homeless populations.

Literature Review Related to Study Designs

Retrospective studies

An overwhelming number of previous TB researchers in the United States employed retrospective population-based studies using NTBSS data. Woodruff, Winston, and Miramonte (2013) predicted through 2020 the number of U.S TB cases among U.S-born and foreign-born persons from selected countries of birth, using NTBSS data from 2000-2010. By log-transforming the data and performing linear regression, they calculated the predicted annual case counts at 95% prediction interval for 2011-2020. Decreases were predicted between 2010 observed and 2020 predicted counts for

total TB cases (11,182 to 8,117 [95% prediction interval, 7,262 – 9,073]) as well as TB cases among foreign-born persons from Mexico (1,541 to 1,420 [1,066 -1,892]), the Philippines (740 to 724 [569 – 922]), India (578 to 553 [455 – 672]), Vietnam (532 to 429 [367 – 502]), and China (364 to 328[249 – 433]). TB cases among persons who were U.S.-born and foreign-born were predicted to decline 47% (4,393 to 2,338[2,112 – 2,586]), and 6% (6,720 to 6,343[5,382 – 7,476]), respectively (Woodruff, Winston, & Miramonte, 2013). Assuming rates of decline observed from 2000-2010 continue until 2020, a widening gap between the number of U.S.-born and foreign-born TB cases was predicted. The researchers concluded that understanding influences of TB prevalence among foreign-born persons, will inform TB control programs in concentrating resources where they can provide the greatest impact on preventing TB disease transmission. Several researchers have determined an association between TB, HIV/AIDS and diabetes co-infection, age, gender, and type of housing (Gao et al., 2013; Sullivan & Ben, 2012; Chant, 2012; Northridge et al., 2010). My study aims to assess if there is an association between being infected with HIV, type of housing/residence, TB prevalence and MDR-TB complications among foreign-born persons in Houston.

Hansel, Merriman, Haponik, and Prette (2004) sought to determine the characteristics associated with in-hospital mortality among patients with TB using the 2000 nationwide inpatient sample of 2,279 admissions of individuals identified with a primary diagnosis of TB, and mortality as the main outcome measure. In a logistic regression analysis with age, gender, race, insurance status, income, Deyo-adapted Charlson Co-morbidity Index (DCI), HIV status, hospital admission source, and hospital characteristics as explanatory variables, found that a disproportionate number of

hospitalized patients with TB were men (64%), nonwhite (72%), lived in areas with median incomes of ≤ $35,000 (50%), and used publicly funded health insurance (49%) (Hansel et al., 2004). Mortality rates among TB in-patients were much higher than non-TB in-patients (4.9% vs. 2.4%, respectively; $p \leq 0.001$). TB in-patients who died were older (mean age, 65.1 vs. 49.4 years, respectively; $p \leq 0.001$), had greater co-morbidity illness (DCL, 1.1 vs. 0.55, respectively; $p \leq 0.001$), required longer hospitalization (19.9 vs. 13.9 days, respectively; $p \leq 0.001$), and accumulated substantially higher charges ($79,585 vs. $31,610, respectively; $p \leq 0.001$, than did TB patients who were alive at hospital discharge (Hansel et al., 2004). In a multivariate analysis, older age, co-morbidity illness, and emergency department admissions were independently associated with mortality. This was a robust study design, but suffered from selection bias since it took account of only U.S.-born TB in-patient population without reflection on any foreign-born TB in-patient subpopulations which bear disproportionate TB disease burden in the United States.

Shah, Cain, Marks, and Cavanaugh (2010) studying the association between mortality risk and HIV co-infection among TB patients using NTBSS data for 1993 to 2008, found that HIV patients were at more risk of acquiring TB, and in turn had a higher mortality risk where there were limited access to antiretroviral therapy. Serpa, Teeter, Musser, and Graviss (2009) in univariate and multivariate study analyses compared data for 1,318- U.S.-born blacks with 565 U.S.-born non-Hispanic whites who participated in the Houston initiative (1995-2004), and found that TB in blacks was associated with HIV seropositivity, younger age, inner city residence and drug resistance. These two studies focused mainly on U.S.-born populations, and calculations on ideal sample size were not

indicated. The foreign-born populations are disproportionately affected by TB and MDR-TB, but factors responsible for TB and MDR-TB disparities between U.S- and foreign-born populations in Houston are not well understood. In my current study I sought to determine if HIV co-morbidity is associated with high TB prevalence and MDR-TB complication among foreign-born populations in Houston.

Kaye (2010) also investigated the impact of HIV on the risk of death during TB treatment by analyzing data for all culture-positive patients with TB from 1993 to 2008 using the NTSS data. The researchers determined the proportion of those who died, and stratified by HIV test results. The study determined that persons with HIV were at increased risk for TB disease, and had a higher risk for death. The researchers concluded that TB mortality rates could be reduced by enhanced TB/HIV programs collaboration and service integration. The researchers did not, however, control for potential confounders such as possible complications from other disease conditions during treatment, and potential differences in healthcare procedures.

Pratt, Winston, Kammerer and Amstrong (2008) in a comparison of demographic, diagnostic, disease characteristics and treatment outcomes between older adults (≥ 65 years of age) and younger adults (≥ 21 years of age), using NTBSS data from 1993 to 2008, with a sample size of 250,784 younger adults and 61,119 older adults, found that older adults had consistently higher incidence of TB than younger adults. Lower percentage of older adults were less likely to have TB diagnostic test results (tuberculin skin test, sputum smear, sputum culture) or HIV infection status reported. TB risk factors (e.g. substance use, homelessness, HIV infection, and multidrug-resistant TB) were less prevalent in older than younger adults. However, older adults had higher rates of TB and

mortality. Seven percent of older adults were dead at diagnosis, and 21% died during therapy compared with 2% and 7%, respectively of the younger adults (Pratt et al., 2008). The researchers conducted a sample study of the persons with TB living in the United States without regard to any other demographic variables other than age. Without controlling for potential confounders or mediating variables, the findings are likely to be either overstated or understated and less generable.

Liu, Wan, Guo, Yang, and Rao (2012) estimated the HIV prevalence in TB patients in Germany, 2002-2009, and characterized the HIV/TB patients demographically. The annual estimates of the HIV-prevalence among TB patients were, on average, 4.5% and ranged from 3.5% (95% CI 2.3-5.1%) in 2007 to 6.6% (95% CI 2.6-5.9%). The HIV/TB patients were characterized by a male-to-female ratio of 2:1, by a median age of 38 years at TB diagnosis, and 59% of the patients were of foreign origin. The researchers demonstrated the universal dimension of TB infections.

Sileshi, Deyessa, Girma, Melese, and Suarez (2013) conducted an institution-based retrospective cohort study to assess predictors of mortality among TB-HIV co-infected patients treated for TB in Ethiopia between April 2009 and January 2012. Patients were categorized into "on ART" and "non-ART" cohorts based on TB antiretroviral therapy(ART). Chi-square test and *t*-test were used for comparison of categorical and continuous variables respectively between the two groups. A Kaplan-Meier test was used to estimate the probability of death after TB diagnosis. A log-rank test was used to compare overall mortality between the groups. A Cox proportional hazard model was used to determine factors associated with death after TB diagnosis. A total of 422 TB-HIV co-infected patients (i.e., 272 on-ART and 150 non-ART)

participated in the study for a median of 197 days. The inter-quartile range (IQR) for on-ART patients was 140 to 221 days, and 65.5 to 209.5 days for non-ART patients. More patients died during treatment in the non-ART cohort 44(29.3%), compared to 49(18%) in the on-ART group. Independent predictors of mortality during TB treatment included: not receiving ART (adjusted hazard ratio [AHR] = 0.35 – 0.64), not initiating cotrimoxazole prophylactic therapy (CPT[AHR] =3.03 [1.58 -5.79]), being ambulatory (AHR= 2.10 [1.22 – 3.62]), CD4 counts category being 0 – 75 cell/microlitre, 75- 150 cells/ml or 150 – 250 cells/ml (AHR =4.83 [1.98 – 11.72], 3.57 [1.48 – 8.61],and 3.07[1.33 – 7.07]} respectively, and treatment at hospital (AHR=2.64 [1.51 – 4.62]). The researchers concluded that mortality was high among TB-HIV co-infected patients, and strongly associated with not taking ART during treatment. This was a robust study, but the researchers did not address potential confounders including socio-demographic and socioeconomic characteristics of the participants.

Another retrospective study was on co-morbidity, incarceration, and homelessness as predictors for failures in timely completion for TB treatment by Mitruka, Winston, and Navin (2012). The researchers examined 1993-2006 trends in timely treatment completion for 2,006 TB cases using a Poisson regression to assess predictors for failures in timely completion for TB treatment. The researchers found that the subpopulations at highest risk for failures in timely completion were persons with combined pulmonary and extra-pulmonary disease (foreign-born adjusted RR [aRR] 3.5, 95CI 2.47 – 4.28; U.S.-born aRR 2.75, 95%CI1.98 – 3.38), or incarceration (foreign-born aRR 2.30, 95%CI 1.80 – 2.93; U.S.-born aRR 1.71, 95%CI 1.36 – 2.14). Other risk factors included homelessness and HIV infection. The researchers did not, however, control for other

known confounding or mediating factors such as age, gender, socio-economic status, country of origin, or previous treatment history.

Reis-Santos et al.(2013) sought to assess socio-demographic and clinical differences in TB patients with and without DM. Using the Brazilian National Surveillance System(SINAN), the researchers compared 1,797 participants with TB and 27,275 participants with DM diagnosed in 2009. Multivariate analysis identified factors associated with the presence of DM among TB patients. The researchers found that participants with TB-DM were older, had initial positive sputum smear test (OR=1.42, 95%CI 1.26 – 1.60), and were more likely to die from TB (OR=1.44, 95%CI 1.03 – 2.01) (Reis-Santos et al., 2013). They were less likely to have been institutionalized (in prison, shelter, orphanage, psychiatric hospital)(OR=0.74, 95%CI 0.60 – 0.93), developed extra pulmonary TB (OR=0.62, 95%CI 0.51 – 0.75), and to return to TB treatment after abandonment (OR=0.66, 95%CI 0.51 – 0.86 (Reis-Santos et al., 2013).

De Perio,Niemeir,and Niemeier (2013) conducted exploratory study in two federal correctional facilities in the Midwestern United States on jail TB transmission based on federal law empowering the National Institute for Occupational Safety and Health to conduct Health Hazards Evaluations for possible workplace health hazards (CDC, 2013h). Pursuant to the empowering statutory provision, a local union requested for an intervention to investigate into potential for TB transmission at the two facilities. The facilities serve as processing centers for adult immigrant detainees entering the United States illegally. Each facility process 100 to 300 immigrant detainees who may be held for as long as 10 hours before re-location to longer-term detention centers. At both facilities, 72 (60%) out of 120 employees were surveyed about work history, medical

history, and history of TB screening. Most (93%) reported face-to-face contact with detainees. Their reported job activities included transporting detainees in enclosed vehicles (68%), interviewing detainees (81%), and supervising court visits (31%). Twenty-five (35%) reported having had face-to-face contact with detainees diagnosed with active TB disease. At both facilities employees who had previously tested negative for TB were screened using a blood test and the tuberculin skin test (TST). A second TST was requested if an employee had not undergone a TST in more than a year. All 59 employees received a TST, but many did not return for their results (26% for the first TST and 22% for the second TST results). Three employees had positive TST results and were referred for further clinical evaluation. Both facilities had ventilation conditions that did not meet CDC recommended requirements and were conducive for active TB transmission through contact. The major weakness of the study is the descriptive nature of the study without use of the inferential statistics to assess and interpret the significance of the study findings.

Several researchers in retrospective population studies have determined an association between country of origin and prevalence of TB. Chen (2008) analyzed the cases of tuberculosis among foreign-born persons in the United States that occurred between 2001 and 2006. The researchers found that during this period, 46,970 TB cases were reported among foreign-born persons, of whom 28% were recent arrivals (within 2 years of entry to the U.S.), and 69% were not recent arrivals. The TB case rates were highest among the recent arrivals. When analyzed by country of origin, case rates in recent arrivals were 3-7 times higher than among non-recent arrivals, with an annual case rate exceeding 250/100,000 population. Among recent arrivals, persons born in sub-

Saharan Africa and Southeastern Asia accounted for 53% of TB cases among recent foreign-born arrivals, although persons from these regions accounted for only 22% of the foreign-born population in the United States. People who had recently arrived from Central America, Eastern Europe, the Pacific Islands and South, East, and Central Asia had an annual TB case rate exceeding 100/100,000 population. The researchers further determined that TB rates among foreign-born persons remained at ≥ 10/100,000 population even among those persons who have lived in the United States for more than 2 decades (more than 10 times higher compared with U.S.-born persons). When analyzed by age at arrival in the United States, TB case rates rose with increased age at arrival. In recent arrivals, annual case rates increased from 25-30 cases/100,000 population among those who arrived at age ≤ 5 years to more than 100 cases /100, 000 population among those who arrived at more than 50 years of age. Similarly, among non-recent arrivals, the annual case rates increased from 5 cases/100, 000 population among those who arrived at age 5 or younger, to 60 cases/100,000 population among those who arrived at more than 60 years of age. TB drug resistance was also a problem among foreign-born persons, occurring in 10-11% of the bacteria isolates compared to 4% among U.S.-born persons. INH- resistance was particularly high among recent arrivals from Vietnam (20%), Peru (18%), the Philippines (17%), and China (16%).Multidrug-resistance occurred in 6% of the recent arrivals from Peru and China compared to only 0.6% among U.S.-born persons. The study once again highlight the existence of TB and MDR-TB disparities among the foreign-born and U.S.-born persons in the United States. The major limitation of the study is the over-reliance on descriptive statistical analyses by the researchers rather than inferential statistics. Inferential statistical analysis is the gold standard for

rigorous research inquiry. Descriptive statistics do not permit making conclusions beyond the data being analyzed, while inferential statistics allow making generalizations about the population from which the sample is drawn, or reach conclusions regarding certain hypotheses (Frankfort-Nachmias & Nachmias, 2008).

Liu et al. (2012) used data from U.S. Department of Homeland Security, U.S. Centers for Disease Control and Prevention, and the World Health Organization to estimate TB incidence among newly arrived foreign-born persons in the United states (defined as persons within one year after arrival in the US). During 2001 through 2008, 11,500 TB incident cases, including 291 multidrug-resistant TB incident cases were estimated to have occurred among 20,989,738 person-years for the 1,479,542,654 newly arrived foreign-born persons in the United States. Of the 11,500 estimated TB incident cases, 41.6% (4783) occurred among immigrants and refugees, while 36.6% (4,211) occurred among students/exchange visitors and temporary works, 13.8% (1,589) occurred among tourists and business travelers, and 7.3% (834) among Canadians and Mexican non-immigrant visitors without an 1-94 Form (e.g. arrival-departure record). The top three newly arrived foreign-born populations with the highest estimated TB incidence cases/100,000 admissions were immigrants and refugees from high-incidence countries (i.e., WHO-estimated TB incidence rates ≥ 100 cases/100,000 population/year; 235.8 cases/100,000 admissions, 95% CI, 228.3 – 243.3), students/exchange visitors and temporary workers from high incidence countries (60.9 cases/100,000 admissions, 95% CI, 58.5 – 63.3), and immigrants and refugees from medium incidence countries (WHO-estimated TB incidence rate of 15 – 99 cases/100,000 population/year; 55.2 cases/100,000 admissions, 95% CI, 51.1 – 58.8). The researchers concluded that non-

immigrants contribute substantially to the TB burden among foreign-born persons. The researchers' main contribution is the affirmation of the disproportionate TB burden among foreign-born immigrants and refugees in the United States, the trend which is likely to continue if nothing is done to reverse it. However, the researchers made no attempt to assess factors responsible for high TB prevalence among foreign-born populations in the United States.

Drug abuse had been reported by some researchers based on population-based retrospective studies as a risk factor for latent TB reactivation and multidrug-resistant TB. Perri et al. (2011) employed population-based study to investigate this phenomena. The objective of the researchers was to establish links between TB patients to form a TB transmission hypothesis by looking at patients infected with same *M. tuberculosis* strain in New York resulting in a TB outbreak in 2004. Initially the tuberculosis strain was drug susceptible. However, in 2006, isoniazid resistance emerged, culminating in isoniazid-resistant TB among 17(31%) patients. The researchers used cluster investigation to link the association between patients for epidemiological links. Pearson X2 or Fisher exact test was used for categorical data, and Mann-Whitney test for continuous data to compare medians, using SAS 5 version 9.1. A larger proportion of patients with isoniazid-resistance were U.S.-born and had a history of illegal drug use. The researchers basically covered U.S.-born population.

Several other researchers have reported multidrug-resistant TB among people with previous history of TB drug use. For example, Deresinski (2012), using reports to the CDC National Tuberculosis Surveillance System analyzed HIV status, MDR-TB, and XDR-TB for data since 1953, and more particularly for 2010 and 2011, and found that

among the 81% of the cases for whom HIV status was known, 7.9% were seropositive. A total of 109 MDR-TB cases were reported in 2010 (the most recent year for which complete data were available), representing 1.3% of those tested. Among persons with no past history of TB treatment, the percentage of MDR-TB had remained stable at 1.0% since 1997,and among those with a history of previous TB treatment, had 4 times higher MDR-TB rates. Foreign-born persons accounted for 82.6% of the MDR-TB cases reported in 2010 and all 4 XDR-TB (100%) cases reported in 2011. No reasons were elucidated by the researchers as to the multidrug- TB resistance disparity among foreign-born persons relative to U.S.-born population.

Drug shortages have been reported as undermining preventive-care and as risk factor for high prevalence of TB and MDR-TB for some populations in the United States. Warkentin et al. (2013) analyzed a nationwide survey data of TB control programs collected in January, 2013 by the National Tuberculosis Controllers Association to assess the extent of drug shortages and the impact on TB control programs. The researchers found that INH shortage was a bottleneck on TB patient care, and could be contributing to TB transmission and MDR-TB complications in the United States. Of the responding health departments, 79% reported difficulties with procuring INH supplies within the last month, 15% reporting they no longer had INH and 41% reporting have not had supply within the one month of the survey. Reported reasons for shortages ranged from local interruption in INH supply, and were dealing with the shortage by changing suppliers (69%), prioritizing patients for treatment of latent TB infection(LTBI) (72%), delaying LTBI treatment (68%), and changing to alternative LTBI treatment regimens (88%)(Warkentin et al., 2013).

The second population-based retrospective study on drug shortage is the Seaworth et al. (2013) study. The researchers sought to investigate the growing TB drug shortages in the United States and implications on TB complications. The researchers found that 26(79%) of the 33 responding public health departments, representing approximately 75% of the U.S. TB burden, reported MDR-TB during 2005-2010. Of these, 21 (81%) reported facing difficulties with second-line drugs (SLD) procurement, citing nationwide shortages (100%), shipping delays (71%), lack of resources (62%), and complicated procurement process related to investigational new drugs (IND) protocol (48%) as main reasons for TB drug supply constraints. Adverse outcomes associated with SLD procurement difficulties reported by 19 (91%) of the 21 jurisdictions included treatment delays (58%), treatment lapses or interruptions (36%), and inadequate regimens (32%). Both studies' outcomes are indicative of problems of TB patients treatment complications associated with shortage of TB drugs. According to Seaworth et al.(2013), 33 reporting jurisdictions represent a relatively low (about 54%) percentage of the National Tuberculosis Controller Association network, and the researcher did not investigate how the TB drug shortages reflected on the TB burden among foreign-born populations.

A third retrospective study to report the problem of drug shortage as a predictor of MDR-TB complication, is by Shah et al. (2012) who investigated the national shortage of isoniazid 300 gm tablets, and found that several states tuberculosis programs have reported shortages of 300 mg isoniazid tablets and that the shortages were undermining their TB treatment and prevention efforts. On November 16, 2012 the Illinois State Tuberculosis Program notified CDC's Division of Tuberculosis Elimination of the national shortage of 300 mg tablets of the anti-TB medication isoniazid. Subsequently,

other state TB programs, including California, Indiana, Maryland, New York, Virginia and Wisconsin have reported difficulties obtaining INH 300 mg tablets. Other programs, including San Diego have experienced difficulties procuring at least one of commercially available anti-TB preparations, obtaining the combination of rifampin and isoniazid. The researchers posit that INH and rifampin are the most important drugs for treatment of TB and latent TB infection (LTBI). For TB it is recommended that patients take up to 11 tablets daily as part of a four-drug regimen (2 rifampin 300 mg, 1 INH 300 mg, 4 pyrazinamide 500 mg, and 4 ethambutol 400 mg tablets) according to the researchers in this study. The researchers determined that fixed-dose combinations decrease tablet numbers and minimizes inadvertent omission of one or more required medications which could lead to drug-resistant TB. The researchers found that a shortage of 300 mg INH tablets would require an increase in daily tablet intake for TB disease from 11 to 13 tablets and for LTBI from 1 to 3 tablets. Increasing the number of required tablets, the researchers found that it decreased compliance. Because of the shortage of INH 300 mg, the researchers found that some TB control programs, such as Maryland, had restricted LTBI treatment to contact persons with infectious TB disease, thus aggravating the problem of TB transmission. Kemper (2013) reports that the national shortage of isoniazid that started in November, 2012, has now spilled-over to most of states. The findings of these researchers is yet another evidence that the problem of anti-TB drug supply limits access to healthcare for TB prevention and treatment, leading to high TB prevalence and MDR-TB complications.

Non-adherence to CDC TB prevention guidelines by health providers has been alluded to by some researchers as partly responsible for high TB prevalence and MDR-

TB complications. Hughes et al. (2010) evaluated the performance of the National Tuberculosis Indicator Project(NTIP)- a national web-based monitoring system that routinely collects surveillance data on individual tuberculosis cases to measure the performance of state and local TB control programs, help programs to prioritize improvement efforts and focus on key TB control activities, and track progress towards national program objectives. The researchers reviewed NTIP data results for the period 2002 -2008, and determined that the program success performance was mixed, with general improvements for indicators related to TB case management (e.g., recommended initial therapy, genotyping data reported, HIV status reported, sputum culture reported, and culture conversion documentation), but unsatisfactory performance was found for indicators related to contact investigation elicitation, medical evaluation of contacts to infectious TB patients, and treatment initiation rate for persons diagnosed with latent TB infection. The researchers determined that all performance indicators remained below the national performance targets for 2015 which include Electronic Disease Notification System, particularly for immigrants and refugee health screening post-U.S. arrival. The researchers collaborates Stahl (2012) findings in Minnesota.

Cross- sectional studies

A cross-sectional study by Rick, Cain, Oeltman, Kammerer, and Moonan (2011) with TB patients with an *M. tuberculosis* isolate genotyped by the U.S. National Genotyping Service, (2005-2009), indicate latent TB reactivation as a risk factor for TB disease. The study used crude odds ratios, and 95%CI to assess relationship between activation of TB and selected factors among foreign-born persons. The researchers concluded that 80% of the TB cases among foreign-born persons can be attributed to TB

reactivation. This finding is against the backdrop of the CDC recommended prophylaxis therapy within 5 months of arrival in the United States to prevent reactivation of latent TB into active TB disease (CDC, 2013j). The mediating factors for reactivation of latent TB into active TB disease among the foreign-born populations were not addressed by the researchers. Additionally, the researchers' findings would have been much stronger if controlling for potential confounders/mediators were addressed and reported.

The second cross-sectional study by Metcalfe et al. (2013) studied the epidemiology of TB and HIV co-infection in California by cross-matching incident TB cases reported to State Surveillance System during 1993-2008 with cases in the state HIV/AIDS registry. Of the 57,527 TB case patients, 3,904(7%) had known HIV infection. Rates were highest among Hispanics (225/100,000 population and Blacks (148/100,000). Patients co-infected with TB-HIV during 2001-2008 were significantly more likely than those infected before highly active antiretroviral therapy became available to be foreign-born, Hispanic, or Asian/Pacific Islander, and to be pyrazimidemono-resistant TB. Mortalities were twice than TB patients without HIV infection. This was a cross-section study for all U.S. residents without specific focus on any foreign-born group.

The third cross-sectional study involved seeking an understanding of the TB predictors and disparities among American Indians, Alaska Natives (AI/ANS), and Native Hawaiians/Other Pacific Islanders (NH/PIS) using NTBSS data from 2003 to 2008, and the Health Resources and Services Administration Area Resource data file for socioeconomic and health indicators by Bloss et al. (2011). The researchers found that among the 82,836 TB cases, 914(1.1%) were AI/ANS and 362 (0.4%) were NH/PIS. In

2008, TB case rates for AI/ANS and NH/PIS were 5.8 and 14.7 per 100,000 population , respectively, rates that were more than 5 and 13 times higher than for non-Hispanic whites (1.1/100,000 population). From 2003 to 2008, AI/ANS experienced the largest decline in TB case rates (-27.4%) for any racial/ethnic group, but NH/PIS had the least percentage decline (-3.5%). However, AI/ANS were more likely than any racial/ethnic group to be homeless, and to use alcohol excessively. The researchers employed descriptive statistics without inferential statistics analyses to test the significance of the findings and support their hypothesis. Secondly, they focused exclusively on U.S.-born populations.

The fourth cross-sectional study was the assessment on the extent to which 20 large jail systems in the United States have implemented the national recommendations for tuberculosis prevention and control in correctional facilities conducted by Robert et al.(2006) . Data was collected through questionnaires to jail directors and TB control directors, observations at the jails, and abstraction of medical records of inmates with TB disease and latent TB infections. The study found that 20% of jail systems (4/20) had conducted an assessment of risk for TB transmission in their facilities, and 55% (11/20) monitored tuberculin skin test conversions of inmates and staff. Sixty-five percent (13/20) of jails had an aggregate record-keeping system for tracking TB status and treatment, which was usually paper-based. Forty-five percent of the jails (9/20) had policies to offer HIV counseling and testing to tuberculin skin test-positive patients, and 75% (15/20) screen HIV-infected inmates with chest radiographs. Three quarters (15/20) had policies to always isolate patients with suspected or confirmed pulmonary TB in an airborne infection isolation room. Half of the jails with airborne infection isolation rooms

(6/12) conformed to Centers for Disease Control and Prevention (CDC) guidelines for monitoring negative pressure. The researchers concluded that improvements are still required in conducting TB risk assessment and evaluations to determine priorities and reduce risk of transmission. The researchers further observed that, although HIV infection is the greatest cofactor for TB development, jails have inadequate information on patients' HIV status to make informed decisions in screening and management of TB and latent TB infections in jails. Jails need to maximize the use of environmental controls to make jail accommodation less susceptible vehicles for TB transmission.

Prospective Cohort Studies

One of the prospective studies to show that support and access to regular primary care may lead to increased LTBI therapy adherence in high risk populations include Goswami et al. (2012) study. Data was collected by structured patient interviews, self-reported questionnaires, clinic intake forms, and U.S. Census data. Adults more than 17 years of age who received LTBI treatment at public health clinics in North Carolina between January, 2008 and May, 2009, were included to participate. The researchers determined that predictors of early LTB treatment initiation included: non-employment reason for screening (RR 1.91; 95%[CI1.0 – 2.51]), close contact to an infectious TB case (RR 2.5, 95%CI1.0 – 2.0), regular primary care (RR 1.4, 95%[CI1.0 – 2.8]), and history of incarceration (RR 1.7, 95% [CI 1.0-2.8]). Persons in the high risk category for progression/transmission of TB disease had higher likelihood of treatment initiation ($p \leq 0.01$), but not completion. The limitations of the study include exclusive focus on U.S.-born persons where reactivity may have played a role for early LTBI treatment initiation.

The second prospective cohort study by Nahind et al.(2011) analyzed race/ethnicity, and self-reported TB infection data from the Coronary Artery Risk Development in Young Adult (CARDIA) study of 5115 black and white participants. After adjusting for socio-demographic and clinical data, black participants were more likely to report TB infection and or disease (OR 2.0; 95%[CI, 1.5 – 2.9]). The researchers confirm disproportionate TB burden among U.S.-born minority populations. The researchers, however, covered only U.S.-born persons; and self-reporting data invariably suffers from response bias, particularly for a stigmatized disease such as TB. No calculations for sample size and effect sizes were indicated.

A longitudinal cohort study conducted by Reed et al., (2013), involving 657 participants at the National Masan Tuberculosis Hospital in the Republic of Korea to investigate the impact of diabetes and smoking on TB mortality. Participant presenting with a first episode of TB or for retreatment of TB were followed from enrollment to completion of treatment. Demographic, clinical, microbiological, and outcome variables were recorded. Results were compared in patients with and without diabetes or smoking history, adjusted for age, cohort, educational level, and alcohol use. The researchers found that diabetes was present in 25% of the patients and was associated with greater radiographic severity and with recurrent or lapsed TB. Diabetes and smoking independently increased mortality risk in the first 12 months upon enrollment. Combined impact of diabetes and smoking yielded a hazard ratio of 5.78. Only 20% of the diabetic participants were no-smokers; 54% smoked ≥ 1 pack/day. The impact of diabetes on mortality was higher among patients ≤ 50 years of age than in older patients. Some studies have reported higher morbidity and mortality among older TB co-morbid patients

(cfs Pratt et al., 2008 ; Reis-Santos et al., 2013). This contradiction needs further assessment. The researchers relied on descriptive statistics, and did not show sample size and effect size computations to allow evaluation of the power of the study.

Restrepo et al. (2011) conducted a prospective study to estimate the contribution of clinically-confirmed diabetes mellitus to TB rates in communities where both diseases are prevalent to inform integrated disease management strategies. Patients 20 years and older at TB clinics at the Texas-Mexico border, were tested for diabetes. The risk of attributable to diabetes was estimated from statistics from corresponding adult population. The researchers found the prevalence of diabetes among TB patients was 39% in Texas and 36% in Mexico. Diabetes contributed 25% of the TB cases studied, 5% by HIV infection. Among the TB patients, more Texans than Mexicans were aware that they had diabetes (19% and 4% respectively). Men were also less frequently than women aware they had diabetes (p= 0.03). Patients with diabetes before the study had, on average, 18 years history of the disease before diagnosis. The researchers found that diabetic patients were at higher risk of contracting TB than non-diabetic patients. The researchers had no calculations for the sample size, and did not control for potential confounding factors.

The fifty prospective study by Winston and Mitruka (2012) examined TB treatment duration by drug-resistance pattern among a national cohort of case patients with TB diagnosis using the NTSS data. They examined cases of culture-positive verified in 2006 to ensure that all patients had at least three years of follow-up. They calculated treatment duration for patients who were alive and had initiated TB therapy at diagnosis and had results for initial drug-susceptibility testing. Treatment duration was calculated

by subtracting the therapy start date from the therapy end date. The 15th day of the month was designated as they day treatment started or ended if that information was missing. Patients who did not complete therapy were censored as of the last known follow-up. Cases were categorized as isoniazid monoresistant, rifampin monoresistant, multidrug resistant (resistant to at least isoniazid and rifampin; or drug susceptible (susceptible to isoniazid, rifampin, and ethambutol and with no known resistance to pyrazinamide). Survival distribution by drug resistance pattern were estimated using Kaplan-Meier analysis and compared using log-rank test statistics. Patient characteristics were compared by using X^2 test, or when cell sizes were ≤ 5, fisher exact tests. At 12 months, the cumulative completion of therapy among patients with drug-susceptible, isoniazid-monoresistant, rifampin-monoresistant or MDR-TB was 87.6%, 81.0%, 17.4% and 1.9% respectively. At 24 months, 74.9% of the patients with rifampin-monoresistant TB and 40.2% with MDR-TB had completed treatment. Treatment duration was shortest for patient with drug susceptible TB (median 252 days), compared with a median of 274, 555, and 766 days for patients with isoniazid-monoresistant, rifampin-monoresistant, and MDR-TB respectively. Differences in treatment duration based on drug susceptibility were significant ($p \leq 0.001$) for all comparisons. The MDR-TB group included four XDR-TB cases (also resistant to any fluoroquinolone and more than one of the injectable drugs- capreomycin, kanamycin, or amikacin). No significant change in duration of treatment was observed when the four XDR-TB cases were removed from the analysis. The researchers concluded that although there has been remarkable decline in MDR-TB since 1993, drug resistance remains a serious problem in the United States because the percentage of isoniazid-monoresistant TB cases has remained stable; and longer

treatment durations persist among patients with isoniazid-monoresistant TB. The researchers did not find any improvement since 1993 in the duration of treatment for rifampin-resistant TB strains either. This was a population-based prospective study involving U.S. general population.

Conwell et al. (2007) prospective study sought to determine factors associated with loss to follow-up after completion of treatment phase in large tuberculosis treatment trial (TBTC/USPHS Study 22) in the U.S. and Canada. A sample size (n=1075) were recruited to participate in the study. Patients lost to follow-up were compared to those reached study end-point or successfully completed follow-up. A generalized estimating equation model was used to combine patient-specific and site-specific factors. 89.8% (965) of the participating patients, reached study end-point (died or completed the 2 year post treatment phase, and 10.2% (110) did not. Multivariate analysis showed that birth outside USA/Canada (OR 2.07, 95% Cl: 1.25-3.40, p =0.005), history of homelessness (OR 1.94, 95% Cl 1.00-3.80, p=0.05), enrollment at a health department (OR2.71, 95% Cl 1.27-5.79, p=0.010), and use of any kind of incentive (cash/cash equivalent) during treatment phase (OR 3.04, 95% Cl 1.73-5.33, p=0.0001) were independently associated with loss to follow-up. The researchers concluded that loss to follow-up compromise successful TB treatment regimens, and completion of treatment regimens is essential to achieving best TB treatment and control outcomes. The major limitation of the study include: the sites were asked only once over a time period of six –year study during which changes in staff and practices may have occurred and influenced information bias. There were potential confounding factors such as transportation to and from healthcare facilities, and family responsibility which patients consider important in their health

seeking behaviors, but were not controlled for in the study. The study also potentially suffered from ecological fallacy as the analysis of many factors were based on the site-level rather than patient level data, and, therefore, experiences of individual patients in relation to site practices is unknown.

Pettit, Bethel, Hirsch-Moverman, Colson, and Sterling (2013) in a prospective study determined the rate and risk factors for discontinuation of isoniazid due to adverse effects from March, 2007 – September 2008 during the treatment of latent tuberculosis infection in large, multi-site study among adults initiating isoniazid for treatment of LTBI at 12 sites in the US and Canada. Relative risk (RR) for isoniazid discontinuation due to adverse effects was determined using negative binomial regression. Adjusted models were constructed using forward stepwise regression. Of the 1306 persons initiating isoniazid, 617 (47.2%), 95% Cl 44.5-50.0) completed treatment, and 196 (15.0%, 95% [Cl 13.1-17.1]) discontinued due to adverse effects. In a multivariate analysis, female use (RR 1.67, 95% Cl 1.32-2.10, $p \leq 0.001$), and current alcohol use (RR 1, 41, 95% Cl 1.13-1.77, $p = 0.003$), were independently associated with isoniazid discontinuation due to adverse effects. The researchers found that women were at an increased risk of discontinuing isoniazid due to adverse effects, and recommended that close monitoring of women for adverse effects in TB treatment may be warranted. The researchers did not control for potential confounding variables which could account for sex-related differences in discontinuation of isoniazid due to adverse effects such as participant's body weight and isoniazid dose. The recommended dose of isoniazid for LTBI treatment is 5 gm/kg daily (maximum dose 300gm daily). Persons weighing ≤ 60 gm may receive 300gm of isoniazid daily due to tablet formulations and preference of single-pill dozing.

It is possible that participants who discontinued isoniazid due to adverse effects were those weighing ≤ 60gm, and still receiving 300gm daily doses. This is likely to be more frequently among women who tend to weigh less than men. The study, therefore, suffers from misclassification bias.

Case-control Study

Wanyeki et al. (2006) designed case-control study to determine whether dwelling and building features, residential density, and crowding were independently associated with TB occurrence in a low-incidence setting. Residential addresses were used to gecode active TB cases reported in Montreal, Canada 1996-2000. The case dwellings were linked to municipal dwelling gecordatabase from 2000, and to Canadian Census data from 1996. Randomly selected Montreal dwellings were selected as controls compared to the case dwellings in a ratio 1:10 using the same data sources. From multivariate logistic regression, the 595 cases dwellings were more likely than the 595 control dwellings to be in building ≥ 5 stories tall (adjusted Odds ratio[OR] 1.6; 95% [Cl: 1.0-2.5)], constructed since 1970 (adjusted OR 2.5; 1.8-3.6), in the lowest quartile for resale valuation (adjusted OR 1.3; 1.0-1.6), and on block where lot coverage exceeds the median value (adjusted OR 1.3; 1.0-1.6). Case dwellings were also more often found in census tracts with more persons per room, and a higher proportion of individuals who has arrived in Canada within the last 5 years. Dwellings on blocks with high residential density as well as crowding were associated with TB occurrence, after adjusting for sociodemographic factors. The study suffers from ecological fallacy because attribution of aggregate data to individuals masks important variations, and; residential addresses as case reporting do not

necessarily capture patient's dwelling at the time of TB transmission- nor do they capture important social interaction at work or other milieus.

Meta-Analysis Studies

Suchindran, Brower, and van Rye (2009) conducted a systematic review and meta-analysis to summarize the evidence of the association between HIV infection and MDR-TB. The original studies providing *M. tuberculosis* resistant TB data stratified by HIV status were identified by using MEDLINE and Is Web of Science. The researchers calculated crude MDR-TB prevalence ratios and analyzed by type of TB (primary or acquired), region and study period. They assessed heterogeneity across studies and generated pooled prevalence ratios. The researchers found no clear association between MDR-TB and HIV infection across time and geographic locations. Comparing MDR-TB prevalence ratios in 32 eligible studies by HIV status ranged from 0.21 to 41.45. Assessment by spatial and temporal dimensions did not reveal noticeable patterns. Prevalence for acquired and primary MDR-TB were (RR=1.17, 95%[CI, 0.86 – 1.), and (RR=2.72, 95%[CI, 2.03 – 3.60]). While the researchers did not demonstrate conclusive evidence of clear association between MDR-TB and HIV, or acquired MDR-TB and HIV, the results suggest an association between HIV infection and primary MDR-TB. This finding requires further investigation for more definitive determination.

Methodological Issues (Limitations) and the Proposed Improvements

An overwhelming number of researchers in recent studies on TB and MDR-TB in the United States have used retrospective population-based NTBSS data analyses with inherent response bias due to perceived desirability of behavior on self-reported ethic conduct (Randal & Fernande,1991). Desirability of behavior on self-reported ethic

conduct is critical and relevant in a context of a stigmatized disease such as TB. Tuberculosis in the United States is currently considered a disease of the foreign-born and minorities populations. The disease is highly stigmatized in some cultures, and particularly among the foreign-born populations. Response bias is likely to be common in self-reported population-based surveys, such as in the NTBSS, with important ramifications on study conclusions. Other biases included ecologic fallacy, such as in Conwell et al., 2007), and misclassification, such as in Pettit et al.(2013).

Most researchers in retrospective studies relied heavily on descriptive rather than inferential statistical analyses in their analyses and findings, such as in Chen (2008), Bloss et al., (2011), and De-Perio et al., (2013). A large number of researchers invariably focused on the U.S.-born populations without much attention to populations disproportionately affected by TB and MDR-TB. Several other cross-sectional and prospective researchers did not indicate sample and effect size calculations (e.g., Ligases et al., 2013; Red et al., 2013; Nahind et al., 2011). Sample size is important because it allows for the researcher to control for Type 11 error (false-negative finding), and permits power analysis to estimate the precision of findings. Sample size is also important for interpretation and generalizability of the study findings (Beau, Kernels, & Porched, 2008). Other researchers did not control for potential confounders (e.g., Rick el al., 2011; Restrepo el al., 2013). Unmeasured confounders in exposure variable can cause considerable problems in epidemiological studies, causing bias either towards or away from the null hypothesis, resulting in either under/over-estimation and erroneous study interpretations (Feel, Smith, & Sterne, 2005).

A vast majority of researchers utilized secondary source of data (i.e., NTBSS). Secondary data can provide methodological advantages, such as large datasets, opportunities for replication of studies, reduce undue exposure of study participants to extra harm, and saves on time and costs (Aponte, 2010), but may also introduce some other methodological limitations associated with differences in time periods. For example, the time between secondary data compilation and use, clinical outcomes observed prior to the current treatment protocols, may present challenges in the formulation of research questions (Dolan & Froehlich's, 2009).

Proposed Improvements

The use of the SEM framework in my study provided a comprehensive multilevel approach of investigating the epidemiological pathways of TB and MDR-TB in TB patients. De-identified TB patient discharge health record at the city's Bureau of TB were used for this study. Medical records have previously demonstrated high validity. Horwitz (1986)(cited in Rudestam & Newton, 2007), found a 93% agreement between medical records and interviews for family history of breast cancer. Patients discharge record at Houston city's Bureau of TB database, was a convenient and reliable source of TB patients' health history and treatment outcomes. My study employed inferential statistical analyses to determine the practical significance of both individual and contextual influences on the prevalence of TB and or MDR-TB among foreign-born populations in Houston to inform effective integrated TB and MDR-TB preventive and control measures.

Summary and Conclusions

Despite efforts in the elimination of tuberculosis (TB), the disease still remains a major public health threat in the United States. Several significant themes in the literature review supported the need for this study. The incidence of TB in the United States declined from 84,304 in 1953 to just 9,945 in 2012 with 529 deaths reported in 2011, while the case rate declined from 53.6/100,000 to 3.2/100,000, over the same time period (CDC, 2012). However, TB and MDR-TB disproportionately affect foreign-born populations. Of the TB cases reported in 2012, 63% occurred among foreign-born persons. The TB case rate in 2012 was 15.6 times higher among foreign-born as in U.S.-born persons. More than 50% of all TB cases reported in 2012 occurred in four states: California, Hawaii, and New York, and Texas (CDC, 2013). Texas had the fourth highest number of reported TB cases of any state in the country, while Houston in Texas was first in the number of TB cases of any city in the state, and third nationally among Metropolitan Statistical Reporting Areas (HDHHS, 2013; TSDHS, 2013). TB incidence rate among U.S.-born residents in Houston decreased from 47.7% in 2009 to a low 42.1% in 2012, but increased among foreign-born residents from 51.1% in 2009 to 57.9% new high in 2012 (HDHHS, 2013)

In addition, cases of multidrug-resistant TB (MDR-TB) and extremely drug resistant TB (XDR-TB) have been reported in the Unites States since 1993 (CDC, 2010), arising from failure to complete treatment plans, misuse or mismanagement of anti-TB drugs, including wrong dosage. Foreign-born populations suffer from a high burden of MDR-TB and XDR-TB. Cases of MDR-TB and XDR-TB are difficult and expensive to treat, costing more than $ 400,000 to treat one case of XDR-TB in hospital, and about a

half that amount for one case of MDR-TB (CDC, 2011). The estimated annual morbidity and mortality TB cost in the Unites States is well over $40 billion (American Lung Association, 2013). Although MDR-TB constitutes a small proportion of total TB case burden, it consumes a disproportionate and substantial portion of the local, state and, national TB budget, suggesting need for evidence-based data to inform rational resource allocation and selection of management strategies for MDR-TB in high TB burden settings. Prevention and control remains the most viable option in the goal of elimination of tuberculosis (Pooran et al., 2013).

Previous TB researchers have employed several study designs including retrospective, cross-sectional, case-control, prospective, and meta-analyses using mainly descriptive statistical analyses and focusing their investigations mainly on U.S.-born populations. A few of the researchers have treated being foreign-born as TB risk factor (e.g., TDSHS, 2013). The research problem is that contextual factors predicting high TB and MDR-TB complications among foreign-born persons in Houston are not clearly understood. No previous serious attempt has been directed at elucidating factors responsible for high incidence and prevalence of TB and MDR-TB among foreign-born populations in Houston, at a time when both TB and MDR-TB incidence and prevalence rates have shown remarkable decline among U.S.-born populations nationally and in Houston. My study sought to fill this gap. Quantifying these risk factors requires a multifactorial approach and the use of multivariate statistical models (Katz, 2006).

I used socio-ecological model framework in this correlational study for assessing multilevel contextual influences on TB and MDR-TB and to explore if being infected with HIV and type of housing (independent variables), impact foreign-born individual's

likelihood of contracting TB disease and MDR-TB complication(dependent variables) in Houston. I treated age, and gender as covariates in this assessment. This approach was addressed by employing quantitative, multivariate analysis techniques as discussed in chapter 3. The findings of this study will support positive social change in suggesting most appropriate public health interventions for the reduction of morbidity, mortality, and healthcare cost from TB disease and MDR-TB complication among foreign-born populations in Houston Texas and in the United States.

Chapter 3: Research Methods

The purpose of this study was to evaluate possible associations between HIV infections and type of housing and TB prevalence and MDR-TB complications among foreign-born populations in Houston, Texas. Drawing from SEM, I sought to assess the association between being infected with HIV, type of housing, and TB prevalence and MDR-TB complications in foreign-born communities in this metropolitan area. I outline in this chapter the protocol that I used to conduct a secondary data analysis . I also discuss how I tested my hypotheses. The chapter is divided into six sub-sections: (a) research design and rationale, (b) setting and sample, (c) instrumentation and materials, (d) data collection and analysis, (e) ethical considerations, and (f) threats to validity.

Research Design and Rationale

The research problem was that contextual predictors for high TB prevalence and MDR-TB complications among foreign-born persons in Houston, Texas, are not clearly understood (Oren et al., 2010). Measuring and quantifying these risk factors require a multilevel and contextual approach and the use of multivariate statistical models (Katz, 2006). The SEM provided a framework for assessing multilevel contextual influences on TB disease and MDR-TB complications. As I discuss in this chapter, I believe that using quantitative and multivariate analysis techniques and a retrospective study design were the most appropriate means of researching my topic.

In the literature review, I demonstrated that the risks for TB disease and MDR-TB complication have been assessed through various study designs, each with its own strengths and limitations. Several researchers in the literature review secured robust sample sizes using secondary data from the National Tuberculosis Surveillance System

(NTBSS; Pettit et al.,2013; Suchindran, Brower, & van Rye, 2009). Researchers also used retrospective designs (e.g. Kaye, 2010; Pratt et al., 2008; Shah et al., 2010; Woodruff et al., 2013), case-control (e.g. Wanyeki et al., 2006), prospective designs (e.g. Nahind et al., 2011; Pettit, Bethel et al., 2013),cross-sectional designs (e.g. Bloss et al., 2011; Parco et al., 2013),and meta-analysis (e.g. Suchindran et al., 2009). The main limitations of these designs were reliance on descriptive statistics whose findings are not generable.

Secondary data analysis have certain merits. Population-based retrospective study designs use large sample sizes, save time and money, do not expose study participants to extra harm due to intervention effects, and avoid unnecessary burdening of the study participants with time consuming interviews (Kelder, 2005). Researchers also may use them for secondary data analysis (Thirsted, 2006). However, these designs have potential selection bias, and the researcher has no control over the manner of data collection and handling (Kelder, 2005).Prospective study designs are more robust, but they are expensive because they require long follow-up periods, researchers using them also have fewer opportunities to effect positive social change in the short-term. Case-control designs are good for rare outcomes and small sample sizes, and are relatively inexpensive; but, they are prone to selection bias (LaMotte, 2013). Cross-sectional studies are inexpensive, but not ideal for assessment of rare or advanced complications in small samples and are also prone to selection bias as well (LaMotte, 2013). Meta-analyses increase statistical power and improve the estimates of the effect size of an intervention or association, but suffer from selection and publication bias (Fagard,

Staessen & Thijs, 1996). Since each of these designs have strengths and limitations, researchers seek designs whose strengths outweigh potential limitations.

Based on my literature review, I contend that retrospective study design allows assignment of diagnosis prior to assessment of complications- permitting the risk precede the outcome (Riegelmak & Hirsh, 1996). I believe that this advantage outweighs the potential limitations of retrospective study designs in quantity, quality, and availability of measurable constructs (Riegelmak & Hirsh, 1996). In my study, I employed retrospective study design by analyzing secondary data of de-identified patient discharge chart health records at Houston Bureau of tuberculosis database. I also used multiple regression analysis to determine if there were associations between independent and response variables. My independent variables were diagnosis of TB and HIV and housing type (homeless and not homeless). My dependent variables were TB and MDR-TB outcomes. I used age and gender as covariates in order to control for potential confounding effects on the outcome variables.

Methodology

Houston, which is located in southern Texas, is the setting for this study. Texas's population is estimated at 25 million, of whom 16% (4 million) are foreign born., Houston's population is estimated at 2 million, of whom 28.3% (0.6 million) are foreign born (U.S. Census, 2010b). The size of foreign-born population in the United states is estimated at 13% (40 million (U.S. Census, 2010c). I selected the foreign-born population in Houston, Texas, for this study because the foreign-born population is disproportionately affected by TB and MDR-TB (CDC, 2012b; El Sahly et al., 2006). Of the TB cases reported in the United States in 2012, 63% occurred among foreign-born

persons (CDC, 2012b). The TB case rate in 2012 was 15.6 times higher among foreign-born than among U.S.-born persons (CDC,2012b). Texas had the fourth highest number of reported TB cases of any state in the country, while Houston was first in the number of TB cases of any city in the state and was third nationally among Metropolitan Statistical Reporting Areas (HDHHS, 2013a; TSDHS, 2013). Convergence of these facts, made Houston an ideal location for my study.

The foreign-born population is also disproportionately affected by multidrug-resistant tuberculosis (MDR-TB) both nationally and in Houston. The percentage of U.S-born patients with MDR-TB has remained below 1.0% since 1998(CDC, 2013a). However, the proportion occurring in foreign-born persons increased from 31% in 1992 to 87.8% in 2012 (CDC, 2013a). Approximately 62.4% of the people living with HIV in Houston are homeless, while 19.4% are in jails (HDHHS, 2013b). Some neighborhoods within Houston/Harris County have heavy TB burden with yearly incidence that vary from 245/100,000 – 754/100,000 population (Feske et al., 2011). TB incidence rate among U.S.-born residents in Houston decreased from 47.7% in 2009 to 42.1% in 2012, but increased among foreign-born residents from 51.1% in 2009 to 57.9% in 2012 (HDHHS, 2013a).

Sampling and Sampling Procedure

Sampling Frame

Medical records of all foreign-born TB patients stored in the Houston Bureau of tuberculosis database for three consecutive calendar years (i.e. 2011 – 2013) constituted the sampling frame for my study. I followed strict inclusion and exclusion criteria in the selection of study participants:

Eligibility criteria

To be included in the analysis, participants met each of the following criteria:

a) Be foreign-born

b) Had been screened and tested negative for TB prior to and upon arrival in the United States

c) Had been diagnosed with TB/MDR-TB more than 2 years upon arrival in the United States

d) Were of any age and gender

Participants not meeting the above four criteria were ineligible for the study analysis.

Power Analysis

Power analysis addressed how much statistical power was required, and the appropriate sample size for the study. Power analysis has four parameters: the effect size, the sample size, the alpha significance criterion, and the power of the statistical test (Ellis,2010). The effect size (commonly grouped into two "families" of effect: differences between groups-also known as the d family, and measures of association – also known as the r family) describes the degree to which the phenomenon of interest is present in the target population and denotes the practical significance of the statistical analysis; the sample size determines the amount of sampling error inherent in the analysis; the alpha significance criterion defines the risk of committing a Type 1 error (probability of incorrectly rejecting the null hypothesis [α] - normally set at 0.05 or lower, and statistical tests are assumed to be non-directional [two-tailed]), and ; the statistical power refers to the implied Type 11 error rate (β) of the test. If the acceptable level of β is 0.20, then the desired power = 0.80 (or 1 – β) (Ellis, 2010).

I downloaded an online general power analysis program (G*Power) to calculate the appropriate sample size (Faul, Elderfelder, Buchner, & Lang (2009). The G*Power for Windows or Mac is an interactive menu-driven program devised by Faul, Elderfelder, Buchner, and Lang (1996) that performs high precision statistical power analyses for most of common statistical tests in behavioral research such as the t-tests, F-tests, and the X^{2} –tests. The following factors were taken into account when using the G*Power sample size calculator to compute the appropriate sample size for my study: (i) the estimated prevalence of TB in Houston, in this instance (0.25 – 0.75%) (Feske et al., 2011) which called for a medium effect size of about 0.10 that could detect the presence of association between the constructs of interest and denote the practical significance of the statistical analysis of the study , (ii) the desired level of confidence (95%), and (iii) the acceptable margin of error (0.05). The G* Power for Windows computation output is depicted on Table 1 below:

Table 1:

*G*Power Analysis Output*

t tests – Linear multiple regression: Fixed model, single regression coefficient

Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	Two
Effect size f^2	= 0.10		
α err prob	= 0.05		
Power (1-β err prob.)	= 0.80		
Number of predictors = 5			
Output:	Noncentrality parameter δ	=	2.8460499
Critical t	= 1.9921022		
	Df =	75	
Total sample size	= 81		
Actual power	= 0.8021900		

Sample size

An appropriate sample size was necessary to ensure sufficient statistical power of the statistical tests that had to be conducted, while at the same time ensuring efficient use of time and financial resources. Following Jacob Cohen's (1962) pioneering work on the power of statistical tests in behavioral research, there is unanimity on the need for statistical power analyses to determine the most appropriate sample size for any given research study (Erdfelder et al., 1996).

Calculating sample size using G* Power 3.1.5 analysis for Windows (Faul et al., 2009) - and two sided significant level set to 95% and a margin of error (α err prob.) of 0.05, I determined that approximately 81 participants were required for a cohort study employing linear multiple regression analysis with a medium effect size ($f^2 = 0.10$) (Cohen, 1988) with a statistical power of 0.80. Based on this calculation I considered a minimum sample size of 81 participants to have sufficient statistical power (0.80) for my study.

Archival Data and Materials

Houston Department of Health and Human Services, Bureau of Tuberculosis (HDHHS) uses the National Electronic Notification System to capture from TB covered entities and report information on TB and MDR-TB events to the Centers for Disease Control and Prevention, Bureau of Tuberculosis (CDC). This is a robust electronic data warehouse developed by the CDC and maintained by HDHHS (Lombardo & Buckeridge, 2007). The system stores laboratory diagnosis and medical prescriptions records (e.g. pharmacy and Medicaid claims). All data is transmitted via Extensible Mark-Up Language (XML) messages in Health Level Seven ([HL7], 2007) which is internationally

recognized standard to organize and transmit health data (LaTour et al., 2003). Data quality in the NTBSS is maintained in standardized codes, validation rules, and data audits. NTBSS uses various internationally recognized standard codes system as advocated by HL7 (O'Carrol et al., 2003). For example, diagnosis codes employ international Classification of Disease, the Ninth Revision, Clinical Modification (ICD -9 – CM).

The data for my study was extracted from the discharge medical records at HDHHS, Bureau of tuberculosis database. Fields utilized in the study plan included data from the personal demographics (i.e. patient information), encounter (i.e. provider visit details), diagnosis, and observation tables. Medical records of de-identified health information were used to collect data for my study. The daily activity logs used by health personnel from the city Bureau of Tuberculosis on routine patient follow-ups was not employed in data collection as it was found to be an administrative tool for the management of TB treatment and not relevant for generation of data for my study. The rationale for the use of medical records was based on the fact that they have previously demonstrated high validity (Rudestam & Newton, 2007). For example, Horwitz (1986) (cited in Rudestam & Newton, 2007) found a 93% agreement between medical records and interviews for family history of breast cancer. Medical records at the point of service are convenient and reliable source of patient health and treatment record. It is also less costly and time saving. The daily activity tool referred to above was not validated because it was not found relevant for the purpose of my study.

Operationalization of the Variables

The constructs relevant to the hypotheses numerated in chapter2 included: TB/HIV co-morbidity; type of housing; TB disease and MDR-TB complication. Potential confounders of age and gender were controlled for in the multivariate model.

Dependent Variables

Primary dependent variables include: TB and MDR-TB outcomes.

Independent Variables

Independent variables include:

a) Diagnosis of TB and HIV

b) Housing type (homeless and not - homeless)

Covariates

To control for intrapersonal level factors, age, and gender were categorized as covariates and controlled for in the multivariate model.

Age. Was recorded as a continuous variable up to the maximum age of 85. Persons over age 85 may experience difficulties in accurately recalling their age (Ahmad et al., 2001), and , therefore, persons over age 85 were recorded as having attained age 85 for purpose of accuracy. Recommended age groups by the World Health Organization include: 0, 1 - 4, 5 - 9, 10 -14,…….., 80 – 85+ (Ahmad et al., 2001). 85+ represent aggregate of the age groups 85-89, 90 -94, 95 -99 and 100+ (Ahmad et al., 2001). In this study, age was collapsed into three age groups: 0 – 24 , 25 - 64 , and 65+ (Anderson & Rosenberg, 1998).

Gender. Was recorded as a dichotomous variable (male =1, and female = 2).

Data Collection and Analysis

Data collection and Management

De-identified data from the city's Bureau of Tuberculosis database was retrieved, stored, cleaned which I analyzed using SPSS version 21 for windows (SPSS, 2012). Data received as event-level, was aggregated to the patient in the SPSS. Data management and univariate, bivariate, multiple and logistic regression analyses were performed using SPSS 21.I subjected risk factors for TB to bivariate, multiple, and logistic regression analysis to determine their influence on TB and or MDR-TB outcomes.

Missing Data

Missing data are part of almost all research studies (Howell, 2012). There are several reasons why data may be missing, including malfunctioning equipment and inaccurate recording. Malfunctioning equipment and inaccurate recording represent examples of data that are missing completely at random (MCAR)- probability that an observation (X_1) missing is unrelated to the value of X_1 or to the value of any other constructs (Howell, 2012), which could well arise in this study. There are a number of alternative ways of dealing with missing data, but listwise deletion approach is the most common (Howell, 2012). Listwise deletion, also known as complete case analysis, means simply ignoring cases with missing data and running the analysis on remaining cases (Howel, 2012; Wang, Sedransk, & Jinn, 1992). Although listwise deletion may result in reduced sample size available for the analysis, it does have advantages compared to other alternative approaches. In particular, under the assumption that data are missing completely at random, it leads to unbiased parameter estimates (Howell, 2012).However, there were no missing data in my study.

Nature of Scales

The independent variable, TB/HIV co-infection, was measured in the nominal level and presented in the SPSS dataset as TB/HIV, and categorized in the primary data as follows:

0 = No HIV

1 = TB/ HIV co-infection

The independent variable, type of housing, was also measured in the nominal scale and presented in the SPSS dataset as HOUTYPE, and categorized in the primary data as:

0 = Not homeless

1 = Homeless

I based categorization of housing on the guidelines by Texas Health and Human Commission Refugees and Immigrants Resettlement and Assistance program (THHC, 2014).

The dependent variables TB and MDR-TB are dichotomous and were measured at nominal level and presented in the SPSS dataset as TB/MDR-TB, and categorized as:

0 = TB outcome

1 = MDR-TB outcome

The list of variables, their scales, and statistical test performed is presented in the data dictionary in chapter 4.

Research Questions and Hypotheses

I used these variables to test the following research questions with corresponding hypotheses in alternative (A) and null (0) forms:

RQ1: Is being infected with HIV associated with the prevalence of TB among the foreign-born populations in Houston?

H_{o1}: There is no relationship between being infected with HIV and prevalence of TB among the foreign-born populations in Houston.

$H_1 1$: Being infected with HIV is related to prevalence of TB among foreign-born populations in Houston.

RQ2: Is being infected with HIV associated with the prevalence of MDR-TB complication among foreign-born populations in Houston?

$H_o 2$: There is no relationship between being infected with HIV and the prevalence of MDR-TB complication among the foreign-born populations in Houston.

$H_2 2$: Being infected with HIV is related to the prevalence of MDR- TB complication among foreign-born populations in Houston.

RQ3: Is housing type associated with the prevalence of TB among the foreign-born populations in Houston?

$H_o 3$: There is no relationship between type of housing and prevalence of TB among foreign-born populations in Houston.

$H_3 3$: Type of housing is associated with TB prevalence among foreign-born populations in Houston.

RQ4 Is housing type associated with the prevalence of MDR-TB complication among the foreign-born populations in Houston?

H_o4: Type of housing is not related to the prevalence of MDR-TB complication among foreign-born populations in Houston.

H_44: Type of housing is related to the prevalence of MDR-TB complication among foreign-born populations in Houston.

Data Analysis

My data analysis plan guided the secondary data analysis examining the association between being infected with HIV, housing type, the prevalence of TB and MDR-TB complication among foreign-born persons in Houston Texas. I performed all statistical analyses using software product SPSS version 21 for windows. I performed data analysis in four stages: univariate, bivariate, multiple and logistic regression analyses (Katz, 2006). I assumed two-tailed tests, p-values and type 1 error of 5% throughout the analyses. I conducted basic statistics tests for demographic data using cross-tabs frequency data for the age and gender data of the de-identified study observation cases compared to the prevalence of TB and MDR-TB complication among foreign-born population in Houston.

Univariate Statistics

I generated descriptive statistics to support the examination of how the scores for the variables under study were distributed, and the underlying characteristics of the raw data (Crosby, DiClement, & Salazar, 2006), to provide a platform from which inferential statistics were conducted (Marshal & Jonker, 2010). Descriptive statistics focused on the

summarization and display of data using both graphics such as the histograms. Other forms of descriptive statistics measures generated included (McHugh, 2003):

1) Shape, Form, or Normality statistics: such as skew (symmetry of distribution), and kurtosis (peakness or flatness of distribution).

2) Central tendency (location statistics): mode, median, and the mean for the continuous variable (age).

3) Measures of dispersion or variation: range, variance, and standard deviation.

4) Quartile and percentile: percentile.

Descriptive statistics were calculated for all dependent and independent variables using means and frequency commands in the SPSS. Dichotomous measures were reported by frequency distribution (counts, percentile). Continuous measures such as age were reported by central tendency (mode, median, and the mean). Data was plotted virtually (histograms) to locate outliers and abnormal observations.

Bivariate Analysis

The main purpose of bivariate analysis was to determine if there was relationship between individual independent and dependent variables (correlation coefficients) and type of this relationship. The Chi-Square test was used for the analysis to test if a statistically significant association existed between of being infected with HIV, type of housing, prevalence of TB and or MDR-TB complication among foreign-born persons in Houston. A p-value ≤ 0.05 and the confidence interval (CI) were used to evaluate the statistical significance of association between independent and dependent variables. If the

p-value ≤ 0.05 and the CI that did not include zero value were observed, the null hypothesis was to be rejected.

Multiple Regression Analysis

All variables that were analyzed at bivariate level were entered into the multiple regression model and their significance evaluated (Katz, 2006). Significance level were evaluated on the p-value ≤ 0.05 and CI values that did not include zero.. The overall R and the R^2 values (Cox & Snell and Nagelkerke test) were used to evaluate the significance of the amount of variance accounted for by the model, and the significance (effect size) of each of the independent variables on the outcome variable. Each of the *b*-weights in the multiple regression were tested for significance to determine whether each of the independent variable is contributing significantly to the variance accounted for in the dependent variable (Munro, 2005).

Unconditional logistic regression was conducted to ascertain which contextual level variables were associated with increased risk for TB disease and or MDR-TB complication (employing odds ratios) among the foreign-born persons in Houston after controlling for intrapersonal variables of age and gender. The split group technique was not performed for internal model validation to test for reliability of observed association because of low variance within each of the variables investigated.

Threats to Validity

There are several potential intrinsic and extrinsic factors that may be threats to internal and external validity of my study that had to be controlled for. Intrinsic factors that may threaten internal validity of this study include (Frankfort-Nachmias & Nachmias, 2008; Sanneh & Pollock, 2010):

1) History – Events that occurred during TB treatment that might have affected the individuals under study and might have influenced the outcome variable. Exposure to health education on the prevention and control of TB during treatment, for example, may influence the MDR-TB outcome among some TB patients.

2) Maturation – This involves biological, psychological or social processes that produce changes in the individual patient's response to TB treatment. For instance belief in personal efficacy in TB prevention and control may trigger psychological responses that may bolster immune response to TB prognosis and prevention of the development of MDR-TB.

3) Experimental mortality – May occur when there are circumstances that may prevent access to complete information on all TB cases, leading to biased data/information.

4) Testing (reactivity) effect – The Tuberculin skin test for TB may sensitize individuals and improve their TB recovery response through a chain reaction of psychological and immune responses.

5) Interactions with selection – Some intrinsic factors may interact with selection factors and present added threats to validity of the study. Commonly cited interactions include: selection – history interactions when study participants are selected from different settings, and that different settings affect their response to TB treatment, and; selection – maturation interactions that occur where differences in physiological development may influence the response to TB

treatment such as differences in TB dose treatment responses between female and male TB patients (Sanneh & Pollock, 2010).

Threats of validity from extrinsic factors may arise from the fact that participants eligible for inclusion in the study during the study period may not necessarily be eligible for another study period due to migration. An individual who received treatment for TB/MDR-TB and covered during the study period may no longer be residing within Houston Texas. This may lead to underestimation of the study findings.

Intrinsic and extrinsic factors that threaten the internal and external validity of my study were controlled by stratification of the study observations by country of origin. It was not possible to draw a random sample as all study observation cases were included in the study, and there were too few observation cases for some countries. It was important , however, to work with the database archivist to ensure that the data for the study was accurate, reliable, precise, unbiased, valid, and appropriate. The construct validity was ensured by using medical record data which has previously shown 93% validity (Rudestam & Newton, 2007). Reliability of the TB field daily log and coding tool used by HDHHS field personnel for TB treatment follow-ups could not be subjected to Crobach's Alpha Test (Field, 2009), as the log and coding tool were found to be purely administrative tools to manage TB treatment.

Ethical Considerations

Although secondary data analysis provides opportunities for development of new knowledge, it should, however, be aligned with the ethical principles of research by minimizing the burden on study participants, while maximizing the potential benefits from the data use. Consequently, protection of participant's confidentiality was central in

successful completion of my study. Confidentiality is defined by the Privacy Act (1974), and HIPAA (1996), as "the assurance that information about identifiable persons, the release of which would constitute an invasion of privacy for any individual, will not be disclosed without consent (except as allowed by law)" (O'Carroll et al., 2003, p. 201). The current legislation on the protection of human subjects in research is sufficient in providing a framework for the use of secondary data in studies, but there was need to balance the need for optimal use of secondary data, and the protection of study participants.

The new electronic environment of data processes has raised new concerns about confidentiality and the threats of data security lapses (Law, 2005). Technology driven data analysis techniques create potential for triangulation of data: the combining of variables that allows identification of specific individuals even though identifying information was removed from the original data set. There was an additional concern for vulnerable populations that could be at particular risk if their confidentiality were breached. Issues of profiling have been raised, and certain populations such as those involved in criminal history, or who are HIV-positive have a high risk of harm if they are identified (Law, 2005).

However, since my study used de-identified secondary data analysis, protection of study participants and the concern for confidentiality was maintained and ethical concerns were less complex than if primary data were to be used. Data mining in the database was contingent upon maintaining confidentiality and security of identifiable health information, and focused on the ethical obligation to good science and the benefit of the community at large. Patient identifiers, such as names were removed and

substituted with numeric codes, using various forms of encryption with an understanding of which identifying items data were needed to be maintained to keep the data useful while protecting the study participants. Furthermore, Institutional Review Board (IRB) approval was sought and obtained both from Walden University and Houston Department of Health and Human Services before collection and analysis of data to ensure that the research study was of sufficient importance to outweigh privacy concerns; that there were sufficient safeguards in place to protect confidentiality and privacy of data, and; that interpretation of the data was valid through accurate presentation and interpretation of the participants' behaviors.

There was no data sharing outside the Dissertation Supervisory Committee, the HDHHS and Walden University IRBs, and as otherwise authorized by the law. Data was stored in a password protected site until the coding and analysis was complete, and downloaded to a password protected personal computer. Completed coded data, field notebooks, codebooks and related study materials were kept under key and lock and will only be destroyed after 7 years.

Summary

In this chapter I describe the quantitative methodology that I undertook for this study. The data source, data analysis, and variables under study have been defined. The study used secondary data analysis to evaluate the association between being infected with HIV, type of housing, TB disease and MDR-TB complication among foreign-born populations in Houston Texas. De-identified data for TB and MDR-TB patients at Houston Bureau of Tuberculosis database were analyzed retrospectively for three consecutive calendar year for which complete data was available. The hypothesized

contextual risk factors related to TB/MDR-TB were analyzed using multiple and logistic regression analysis while controlling for intrapersonal risks such as age, and gender. The results and findings of the study analysis of the independent and dependent variables and their association are presented and discussed in chapter 4.

Chapter 4: Results

My purpose in carrying out this retrospective cohort study was to examine whether diagnosis of HIV and type of housing were associated with the prevalence of TB and/or MDR-TB among foreign-born populations in Houston, Texas, after controlling for age, gender, and country of origin. I used SEM as a theoretical framework because of its perspective that intrapersonal and interpersonal factors might contribute to health status of individuals (Stokol, 1996). (CITE). The risk factors contributing to TB and MDR-TB among foreign-born persons, in a setting of declining prevalence of TB and MDR-TB among U.S.-born populations in Houston (CITE), is not fully understood. I tested the following research questions and corresponding null and alternative hypotheses:

RQ1: Is being infected with HIV associated with the prevalence of TB among foreign-born persons in Houston?

*H0*1: There is no relationship between being infected with HIV and prevalence of TB among foreign-born people in Houston.

$H_1$1: Being infected with HIV is related to the prevalence of TB among foreign-born people in Houston.

RQ2: Is being infected with HIV associated with the prevalence of MDR-TB complication among foreign-born people in Houston?

$H_0$2: There is no relationship between being infected with HIV and the prevalence of MDR-TB complication among the foreign-born populations in Houston.

$H_2$2: Being infected with HIV is related to prevalence of MDR- TB complication among foreign-born populations in Houston.

RQ3: Is housing type associated with the prevalence of TB among the foreign-born populations in Houston?

$H_0$3: There is no relationship between type of housing and prevalence of TB among foreign-born populations in Houston.

$H_3$3: Type of housing is associated with TB prevalence among foreign-born populations in Houston.

RQ4 Is housing type associated with the prevalence of MDR-TB complication among the foreign-born populations in Houston?

$H_0$4: Type of housing is not related to the prevalence of MDR-TB complication among foreign-born populations in Houston

$H_4$4: Type of housing is related to prevalence of MDR-TB complication among foreign-born populations in Houston.

I begin by describing my protocol for data collection. I then present descriptive statistics, and bivariate association, multiple, and logistic regression analyses. After each set of results, I offer my interpretation of key findings.

First, I sought approval of the IRB at Walden University to collect data after receipt of approval of my research protocol by the Supervisory Committee and URR.. The University IRB directed me to seek the approval of my research protocol by Houston Department of Health IRB first before granting their approval for final study. Houston Department of Health approved my research protocol and their approval is appended as Appendix C. The University IRB then cleared the way for data collection and analysis at Houston Department of Health, Bureau of Tuberculosis.

I retrieved data from the Houston Department of Health and Human Services' Bureau of Tuberculosis database. The archival TB database included having de-identified health records (i.e., where numerals replaced individuals' names) of foreign-born persons of any age, gender, and country of origin who had developed TB and or MDR-TB within 2 years of arriving in the United States. I retrieved data from years 2011-2013 (N = 341). I found my observation cases by using the structured query language (SQL) program and "selection statement" key with parentheses for the variables of interest: "TB disease", "MDR-TB disease", "diagnosis of HIV", "type of housing/residence", "country of origin", "age", and "gender". I cleaned and saved data in a password-protected Microsoft Excel program. I then saved data on a CD which I placed under lock and key. Later, I transferred data to a password-protected SPSS program on a personal computer. These data will not be destroyed until after expiry of seven years from the publication of my research.

Recoded Variables

I created three new variables. I merged TB and HIV observation cases to create a TB/HIV co-infection variable. I merged living in an apartment/house with homelessness to create type of housing/residence variable. I also merged TB and MDR-TB to create a TB/MDR-TB variable. I recoded these variables to make them amenable for the types of statistical analyses I wanted to perform. The final variables that were entered on the data view of the SPSS program for analysis are summarized on in Table 2 below.

Table 2

Data Dictionary

Name of variable	SPSS variable name	Type of variable	Values given to variable	Levels of measurement	Statistical test
TB co-morbidity	TB/HIV co-infection	Independent	0 = No HIV 1 = HIV co-infection	Nominal (categorical)	Chi-Square
Type of housing	Housing	Independent	0 = Not homeless	Nominal (categorical)	Chi-Square
			1= Homeless	Nominal (categorical)	Chi-Square
TB/MDR-TB	TB/MDR-TB	Dependent	0 = TB outcome 1 = TB/MDR-TB outcome	Dichotomous	Chi-Square
Sex	Gender	Demographic variable	1= Male 2= Female	Dichotomous	Descriptive Frequency
Age	AGE	Demographic variable	various	Continuous	Descriptive (Mean)

The Study Sample

Applying the sampling selection and exclusion criteria outlined in chapter 3, data for a total of 341 foreign-born TB observation cases who developed TB or and MDR-TB within two years of arrival in the United States between 2011 and 2013 were retrieved and analyzed. The study sample comprised of 65% male (n = 220) and 35% females (n =121) with ages ranging from 3 to 93 years. The sample cases represented individuals who came to the United States from 46 different countries. The majority were from Central and South America (61%), Asia (29%), and sub-Sahara Africa (10%). Data screening indicated that there were no data or values missing among the observation cases.

Descriptive Results

Data for all eligible observations were analyzed and descriptive results for each of the constructs of interest in the study were generated and are presented in Table 3, followed by summary of the results by type of variable: dependent, independent, and covariates.

Table 3

Frequencies and Percentages for Observation's Demographic Characteristics in the TB Database

Demographic	N	Percentage
Gender		
Male	220	64.5
Female	121	34.5
Age		
0 -24	42	12
25 - 64	250	74
65+	49	14
Co-morbidity		
TB/HIV co-infection	36	10.6
TB disease	305	89.4
Housing Type		
Living in house/apartment	339	99.4
Homeless	2	0.6
TB/MDR-TB Status		
TB/MDR-TB	4	1.2
TB	337	98.8

Country of Origin		
Angola	2	0.6
Belize	1	0.3
Bhutan	2	0.6
Bolivia	1	0.3
Bosnia	3	0.9
Burma	3	0.9
Burundi		
Cameroon		
Canada	1	0.3
Central African Republic	1	0.3
China	11	3.2
Congo	2	0.6
Cuba	2	0.6
Dominica	1	0.3
Dominican Republic	1	0.3
Ecuador	1	0.3
Egypt	1	0.3
El Salvador	22	6.5
Equatorial Guinea	1	0.3
Eritrea	4	1.2
Ethiopia	6	1.8
Ghana	1	0.3
Guatemala	20	5.9
Haiti	1	0.3
Honduras	32	9.4
India	17	5.0
Iran	1	0.3
Ireland	1	0.3
Kenya	4	1.2

(table continues)

Korea	4	1.2
Liberia	1	0.3
Malaysia	1	0.3
Mali	1	0.3
Mexico	122	35.8
Nepal	4	1.2
Nigeria	4	1.2
Pakistan		
Peru	2	0.6
Philippines	14	4.1
Sierra Leon	3	0.9
Syria	1	0.3
Taiwan	1	0.3
Trinidad-Tobago	1	0.3
United Arab Republic	1	0.3
Vietnam	31	9.1
Zambia	1	0.3
Total	341	100

(table continues)

Dependent Variable

TB and MDR-TB outcomes. Four of the observation cases (1.2%) had MDR-TB resistance of whom 25% were males and 75% were females; while 98.8% had TB disease but no MDR-TB complication.

Independent Variables

TB/HIV co-infection (denoted special therapy). A total of (n =33), 10.6% of the observation cases had TB/HIV co-infection of whom (n =26), 72% were males

(n=10), and 28% were females; while 89.4% of the observation cases had no TB/ HIV co-infection.

Homelessness. A high percentage (99.4%) of the TB observation cases lived in houses/apartments; while a small portion of 0. 6% were homeless. Homeless cases were all males.

Covariates

Age. Figure 3 summarizes age distribution of the eligible observation cases. The mean age was 43.8 years, with two peaks of TB disease prevalence in age groups 18 – 42, and 46 – 65, with positively skewed distribution and steep kurtosis. Table 3 shows that, overall, age group 24 – 64 experienced the greatest TB disease burden (74%) compared with age groups 0 – 24 (12%) and above 65 (14%).

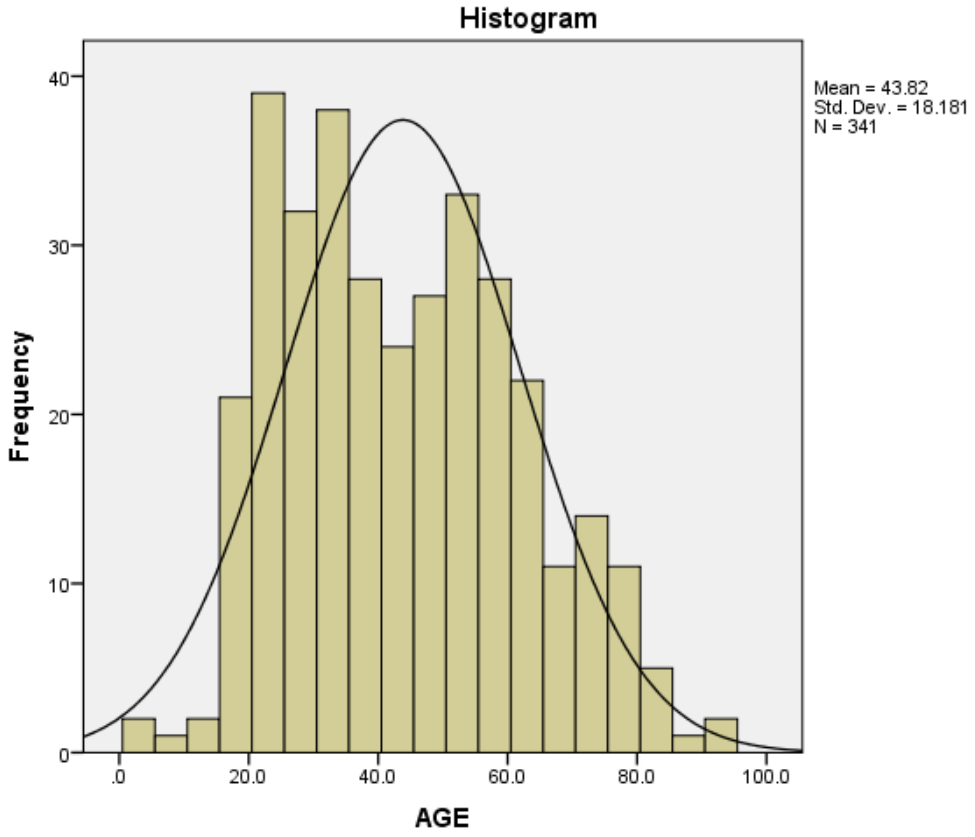


Figure 3: Age distribution of the observations cases

Gender. The male gender constituted majority of the observation cases, 65% (n = 220), while females were 35% (n =121) of the observation cases.

Country of origin: Table 3 shows that study cases came from 46 different countries with majority coming from South and Central America, Asia, and sub-Sahara Africa. Individual countries with the highest representation include Mexico (35.8%), Honduras (9.4%), Vietnam (9.1%), El Salvador (6.5%), Guatemala (5.9%), India (5.0%), Philippines (4.1%), and China (3.2%).

Bivariate Linear Regression

Bivariate linear regression analyses were performed, first with each of the independent variables individually, and then with both variables jointly through forced entry. The purpose of the analysis was to evaluate how best TB/HIV co-infection and type of housing predicted the prevalence of TB and MDR-TB among foreign-born populations in Houston. The results for special therapy (TB/HIV co-infection), type of housing, and the model summary are presented below.

Diagnosis of TB/HIV co-infection was positively, but weakly associated with TB/MDR-TB (R = 0.037), and accounted for only 0.1% of the variance in the dependent variable (R^2=0.001). Type of housing was also weakly associated with TB/MDR-TB outcome, and accounted for no variability in the dependent variable. When the independent variables were entered together, the model indicated that it was still a weak predictor of TB/MDR-TB outcome (R = 0.038), and accounted for 0.1% of the variability in the dependent variables (R^2 = 0.001).

Table 4 shows the model coefficients. The β values for both TB/HIV co-infection (β = -.013) and type of housing (β = -.007) indicate inverse associations with the dependent variables suggesting that persons with HIV infection were more likely than non- HIV infected persons to develop TB, and persons with MDR-TB were less likely to be HIV infected. However, this relationship was non-significant (*p* =.499 ; 95% [CI -.051, .025]). Likewise, homeless persons were more likely than persons with housing to develop TB/MDR-TB outcomes. The relationship between type of housing and TB/MDR-TB was also statistically insignificant (*p* =.931; 95% [CI -.158, .145]).

Table 4

Model Coefficients

Model	*Unstandardized Coeffients*		*Standardizes Coefficients*	*t*	*Sig.*	*95% Confidence Interval for B*	
	B	*Standard Error*	*Beta*			*Lower Bound*	*Upper Bound*
(Constant)	*.013*	*.006*		*2.121*	*.035*	*.001*	*.025*
TB/HIV	*-.013*	*.019*	*-.037*	*-677*	*.499*	*-.051*	*.025*
Type of Housing	*-.007*	*.077*	*-.005*	*-086*	*.931*	*-.158*	*.145*

a. *Dependent Variable: TB/MDR-TB*

b. *Predictors: (Constant), TB/HIV, Type of Housing.*

The model coefficients, therefore, indicate that the association between TB/HIV co-infection, type of housing/residence and prevalence of TB and MDR-TB were not statistically significant, $p \geq 0.5$, and 95% confidence intervals include zero values (95% [CI -0.051, 0.025; -0.158, 0.145]) respectively.

Multiple Regression

Intrapersonal factors were introduced in the multiple regression by forced entry to determine how the independent variables predicted the outcome variables. Multiple regression analysis showed that diagnosis of TB/HIV co-infection, and type of housing/residence were positively associated with the TB/MDR-TB outcome (R = 0.104), and the predictive power of the model improved from 0.1%, reported in the bivariate regression analysis, to 1.1% ($R^2 = 0.011$).

Multiple regression model coefficients in Table 5 indicate that after controlling for age, gender, and type of housing/residence, the association between being infected with HIV and TB/MDR-TB was negative suggesting that people with HIV than people without HIV infection were more likely to contract TB (β = -.010), but the relationship was statistically non-significant(*p = .596; 95% [CI -.048, .028]).* While controlling for age, gender, and TB/HIV co-infection, the association between type of housing and TB/MDR-TB outcome was also negative (β = -.002) indicating that homeless people were more likely than people with some sort of housing to contract TB/MDR-TB outcomes. However, the relationship was also statistically insignificant (*p =.978; 95% [CI -.154; .150]).*

Table 5

Multiple Linear Regression Model Coefficients

Model	*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*	*95% Confidence Interval for B*	
	B	*Std. Error*	*Beta*			*Lower Bound*	*Upper Bound*
Constant	*-.025*	*.024*		*-1.049*	*.295*	*-.071*	*.022*
TB/HIV	*-.010*	*.019*	*-.029*	*-.531*	*.596*	*-.048*	*.028*
Type of Housing	*-.002*	*.077*	*-.001*	*-.027*	*.978*	*-.154*	*.150*
AGE	*.000*	*.000*	*.036*	*.652*	*.515*	*.000*	*.001*
GENDER	*.021*	*.012*	*.093*	*1.698*	*.090*	*-.003*	*.045*

Dependent Variable: TB/MDR-TB

Logistic Regression Analysis

Logistic regression analysis was conducted to determine the odds ratio for the association between TB/HIV co-infection, type of housing and TB and MDR-TB outcomes. The amount of variation in the dependent variables TB and MDR-TB accounted by the independent variables of diagnosis of HIV and type of housing/residence ranged between 1.2% and 9.6% (Cox & Snell R^2 =.012; Nagelkerke R^2 =.096).The Omnibus Test of Model Coefficients chi-square significance (*p*) value was = .4 which is more than .05, indicating that the model was a weak predictor of TB and MDR-TB outcomes, and presence of more influential predictors of TB and MDR-TB not captured in this model. The results of the logistic analysis are presented on Table 6 below.

Table 6

Logistic Regression Model Analysis

Model	*B*	*SE*	*Wald*	*df.*	*Sig.*	*Exp (B)*	*95% CI for Exp(B)*	
							Lower Bound	*Upper Bound*
TB/HIV	*-16.523*	*6411.863*	*.000*	*1*	*.998*	*.000*	*.000*	
Type of Housing	*15.173*	*25957.571*	*.000*	*1*	*1.000*	*.000*	*.000*	
AGE	*.017*	*.026*	*.400*	*1*	*.527*	*1.017*	*.966*	*1.070*
GENDER	*1.752*	*1.163*	*2.268*	*1*	*.132*	*5.767*	*.590*	*56.402*
Constant	*-7.818*	*2.517*	*9.647*	*1*	*002*	*.000*		

Predictor Variables: TB/HIV, Type of Housing, Age, Gender, Constant

The Wald test was performed to determine if the predictor variables, diagnosis of TB/HIV and type of housing/residence, make significant contribution to TB and MDR-TB outcomes. The significance (*p*-value) of the Wald test was .998 for TB/HIV co-infection(lower 95% [CI =.000, and no upper 95% CI bound was given]) ; 1.000 for the type of housing/residence (lower 95% [CI = .000 with no upper 95% CI bound given]), indicating that the independent variables of diagnosis of HIV and type of housing/residence did not make significant contribution to the dependent variables, TB and MDR-TB outcomes. The odd ratio, Exp(B), for the association of TB/HIV co-infection, and type of housing/residence for TB and MDR-TB outcomes indicated inverse relationships respectively [Exp(B) =.000] suggesting that people with HIV were more likely than people without HIV co- infection to contract TB than MDR-TB. Similarly, homeless persons were more likely than persons living in some form of

housing to contract TB than MDR-TB. And men were six times more likely than women to contact TB [Exp(B) = 5.767. This determination means that an increase in TB/HIV co-infection leads to an increase in the prevalence of TB and MDR-TB, while an improvement in housing/residence conditions reduces prevalence of TB and MDR-TB. This determination is similar to findings in the bivariate and multiple regression analyses, and supported by other studies reported in the existing literature.

Model diagnostics

Table 7 presents test results for the assumption of collinearity. The Tolerance values are ≥ 0.1, and the VIF values are less than 10, indicating that the model has no serious collinearity problems.

Table 7

Model Tests for Collinearity

Model	*Collinearity Statistics*	
	Tolerance	*VIF*
TB/HIV	*.977*	*1.024*
Type of Housing	*.986*	*1.014*
AGE	*.985*	*1.015*
Gender	*.992*	*1.008*

Findings

The variables of TB/HIV co-infection, and type of housing/residence were examined to address the research questions and hypotheses, controlling for intrapersonal

factors of age, and gender. The results of testing the research questions with corresponding in alternative (A) and null (0) hypotheses are summarized below.

Research Question 1

Is being infected with HIV associated with the prevalence of TB among the foreign-born populations in Houston?

$H_0$1: There is no relationship between being infected with HIV and prevalence of TB among the foreign-born populations in Houston.

$H_1$1: Being infected with HIV is related to prevalence of TB among foreign-born populations in Houston.

The nature of the association between TB/HIV co-infection and TB and MDR-TB was examined by running a bivariate, and multiple regression analyses, and determined that there was an association between being infected with HIV and TB/MDR-TB. Table 5 indicate that after controlling for age, gender, and type of housing/residence, the relationship between TB/HIV co-infection and the prevalence of TB and MDR-TB was not statistically significant (B = -.010; p = .596; 95% CI -.049, .027), and hence the study fails to reject the null hypothesis.

Research Questions 2

Is being infected with HIV associated with the prevalence of MDR-TB complication among foreign-born populations in Houston?

$H_0$2: There is no relationship between being infected with HIV and the prevalence of MDR-TB complication among the foreign-born populations in Houston.

$H_1$2: Being infected with HIV is related to prevalence of MDR- TB complication among foreign-born populations in Houston.

The outcome variables of TB and MDR-TB were merged to create a new outcome variable of TB/MDR-TB, and, therefore, the findings in research question 1 and the corresponding hypotheses, applies to research question 2 and the corresponding hypotheses.

Research Question 3

Is housing type/residence associated with the prevalence of TB among the foreign-born populations in Houston?

$H_0$3: There is no relationship between type of housing and prevalence of TB among foreign-born populations in Houston.

$H_3$3: Type of housing is associated with TB prevalence among foreign-born populations in Houston

Similarly, the association between type of housing/residence and TB/MDR-TB was examined by both bivariate and multiple regression analyses. Table 5 indicate that controlling for age, gender, and TB/HIV co-infection, the association between type of housing/residence, and the prevalence of TB and MDR-TB outcome is statistically insignificant (B = -.002; p = .978; 95% CI -.154, .150). This relationship was supported by the logistic regression analysis, and the study fails to reject the null hypothesis.

Research Question 4

Is housing type/residence associated with the prevalence of MDR-TB complication among the foreign-born populations in Houston?

$H_0$4: Type of housing/residence is not related to the prevalence of MDR-TB complication among foreign-born populations in Houston

$H_4$4: Type of housing/residence is related to prevalence of MDR-TB complication among foreign-born populations in Houston.

As I discussed earlier on the recoded variables, the outcome variables of TB and MDR-TB were merged to create a new outcome variable of TB/MDR-TB, and, therefore, the findings in research question 3 and the corresponding hypotheses, applies to research question 4 and the corresponding hypotheses.

Type of housing and residence predictor variables were merged to create the new independent variable type of housing/residence, and therefore, the test results for research question 3 and corresponding hypotheses applies to research question 4 and corresponding hypotheses.

Summary Results

The results of the null hypothesis testing indicated that diagnosis of HIV, or type of housing/residence were not related to the prevalence of TB and MDR-TB. No statistically significant association were found between being infected with HIV, type of housing and prevalence of TB/MDR-TB among foreign born-persons in Houston, and the null hypothesis is upheld. I determined in these analyses, however, that TB/HIV co-infection and type of housing were inversely associated with prevalence of TB and MDR-TB, suggesting that HIV infected persons are more likely than non- HIV infected persons to contract TB, and MDR-TB persons are less likely to be HIV positive. Homeless persons are more likely than non-homeless persons to contract TB/MDR-TB outcomes. This means that high TB/HIV co-infection rates increase prevalence of TB

since HIV infected persons are more likely than non-HIV infected persons to contract TB. Likewise, improvement of housing conditions reduces prevalence of TB and MDR-TB. Nevertheless, since the association between being infected with HIV, type of housing, TB and MDR-TB were statistically insignificant, these results should, be interpreted with some caution. Even with modest levels of prevalence, tuberculosis and multidrug-resistant tuberculosis are insidious and debilitating conditions to human health, and place enormous social and economic cost burdens on individuals, communities and even nations. The practical implications of the relationships that I elucidated in this study could be profound in terms of elimination of TB, MDR-TB, and reduction of social and economic costs associated with TB and MDR-TB in the United States.

The results of the study findings will be discussed in more detail in the next chapter in the context of previous published research, recommend tangible improvements for TB and MDR-TB prevention and disease management among foreign-born populations, suggest pathways for future research efforts, social change implications, and make practical recommendations for public health practice for the reduction and ultimate elimination of TB and MDR-TB and associated costs in Houston and the United States.

Chapter 5: Discussion, Conclusion, and Recommendations

Study Overview

This is the first research study that I am aware of that elucidates the risk factors associated with the prevalence of TB and or MDR-TB among foreign-born persons in Houston, Texas. A comprehensive review of the literature did not reveal any published studies that specifically examine the association between TB/HIV co-infection, type of housing/residence, prevalence of TB and MDR-TB complication in this population. The study sample include 341 observation TB cases covering three consecutive years (2011, 2012, and 2013). I used secondary data because of time and cost considerations. I selected Houston as my focal city because its foreign-born population accounts for 57% of the TB cases in the city, even though it comprises only 25% of the city's total population (U.S. Census, 2010) coming from all continents.

My purpose in carrying out this study was to examine whether there is an association between being HIV infected and type of housing/residence, and TB and or MDR-TB, while controlling for intrapersonal factors of age and gender. I used the SEM theoretical framework to design and conduct this investigation. Diagnosis of HIV and type of housing/residence were focal contextual factors in my study. I used secondary data of de-identified TB patient medical records from the Houston Department of Health and Human Services' Bureau of Tuberculosis database to analyze potential association between diagnosis of HIV, type of housing/residence and prevalence of TB and or MDR-TB among foreign-born persons in Houston using multiple and logistic regression analyses. My results suggested an inverse relationship between diagnosis of HIV and TB and MDR-TB. The relationship between type of housing/residence and TB and or MDR-

TB was also inverse. However, these associations were not statistically significant both before and after controlling for intrapersonal factors. Although statistically significant association between being infected with HIV, type of housing/residence, prevalence of TB and MDR-TB outcomes were not determined, the analysis indicate an association between these variables.

I have organized this chapter into three interrelated sections. First, I contextualize my findings by considering similar local, regional and international research. I then offer practical recommendations for public health practice. In the last section, I suggest pathways for future research. I conclude the chapter by discussing implications for positive social change.

Interpretation of the Findings

Intrapersonal Factors

I treated age, and gender as covariates in the analysis.

Age. The average age of individuals in the observation sample was 43.82 years (SD =+/- 18.18). In this analysis, I observed that the age groups (25 – 64) experience disproportionate TB disease burden (74%) compared with age groups 0 - 24 (12%) and those aged 65 and older (14%). The relationship between age and TB and MDR-TB event was positive but statistically insignificant. The odds for TB and MDR-TB resulting from age, Exp(β) = 1.017, p = 0.527; 95% Cl [0.966 - 1.070], indicating insignificant relationship. Pratt, Winston, Kammerer and Amstrong (2008), found that older adults had consistently higher incidence of TB than younger adults. Older adults were less likely to have TB diagnostic test results or to have reports of HIV infection.

Gender. The foreign-born population accounts for 25% of the Houston population, with males accounting for 60% , and females accounting for 40% of this group (U.S. Census, 2013; U.S. Census, 2010)). In this study, males constituted 65% of the observation sample and females 35%.There was a positive relationship between gender and TB and MDR-TB outcomes. The odds for TB and MDR-TB resulting from gender, Exp (β), conceptualized (Stokol, 1996). =5.767, $p = 0.132$; 95%Cl [0.590 - 56.402]. I observed higher risk for TB and MDR-TB events among males than among females. In the logistic regression analysis, males were more likely than females to develop TB and MDR-TB than females (OR ≈ 6).

This finding on males' more vulnerability to TB than females is similar to Valadas et al.'s (2013) retrospective TB co-morbidity study at the Hospital Sanatorio de Luanda in Angola. The researchers found that the rate of TB/HIV co-infection was 37.4% and overall mortality was 15.2%. A majority of their cases were males (58.3%) adults (68.2%). In a retrospective study of patients with pulmonary tuberculosis at a private medical college hospital in Coimbatore, India, Rajam and Muhammad (2013) found that most HIV-positive patients with tuberculosis were males (87.5%) and prevalence of HIV co-infection among patients with tuberculosis was highest in patients aged 33 - 48 years. Liu, Wan, Guo, Yang, and Rao (2012) estimated the HIV prevalence in TB patients in Germany for 2002-2009 and characterized the HIV/TB patients demographically. The annual estimates of HIV-prevalence among TB patients were, on average, 4.5%; they ranged from 3.5% (95% CI [2.3 -5.1%]) in 2007 to 6.6% (95% CI [2.6-5.9%]). The HIV/TB patients were characterized by a male-to-female ratio of 2:1, by a median age of

38 years at TB diagnosis, and 59% of the patients were of foreign origin. These findings suggest that majority of TB/HIV patients were older males.

Contextual Factors

Being infected with HIV and type of housing were identified as risk factors for TB and MDR-TB from the literature review, and I hypothesized them as potential risk factors in this study.

TB/HIV Co-infection. I gleaned from the literature review that HIV infection accelerates incidence and prevalence of TB by weakening the patient's immune system (Myers & Sepkowitz, 2008). Several researchers have established strong associations between TB/HIV co-infection and prevalence of TB. Gao, Zheng, and Fu (2013) determined the prevalence of TB and HIV co-infection worldwide by using meta-analysis based on a systematic review of published articles. They found that estimates of TB/HIV co-infection prevalence ranged from 2.93% to 72.34%. Prevalence of TB/HIV co-infection was 31.25% (95% CI [19.30 - 43.17]) in African countries, 17.21% (95% Cl [9.95 - 24.46]) in Asian countries, 20.11% (95% Cl [13.2 - 26.39]) in European countries, 25.06% (95% Cl [19.25 - 30.84]) in Latin American countries, and 14.84% (95% Cl [10.44 - 19.24]) in the US.

In a study of the association between mortality risk and HIV co-infection among TB patients, Shah, Cain, Marks, and Cavanaugh (2010) found that HIV patients were at greater risk of acquiring TB and consequently had a higher mortality risk when they had limited access to antiretroviral therapy. Serpa, Teeter, Musser, and Graviss (2009) compared data for 1,318- U.S.-born African Americans with 565 U.S.-born non-Hispanic Whites who participated in the Houston TB Study Initiative (1995-2004) and found that

TB in African Americans was associated with HIV seropositivity, younger age, inner city residence, and drug resistance. Metcalfe et al. (2013) determined that patients co-infected with TB/HIV during 2001–2008 were significantly more likely than those infected before highly active antiretroviral therapy became available to be foreign-born persons. There is a negative association between diagnosis of HIV and TB and MDR-TB outcomes after controlling for age, gender, and type of housing. Metcalfe et al.(2013) finding suggest that persons with HIV infection were more likely to develop TB than persons without HIV infections. This relationship was, however, statistically insignificant (p = .596; 95% Cl [.048, .028]). This finding is supported by logistic analysis in my current study.

Type of Housing. Type of housing/residence has crucial environmental influence on health (Northridge, Ramirez, Stingone and Claudo, 2010). Housing provides shelter and security and is considered a fundamental development process in which the built environment is created, used, and maintained for physical, social, and quality of life of individuals and populations (Lawrence, 2004). Several researchers have reported association between type of housing/residence and TB outcomes. Garcia (2004) reported linkages between poverty, crowded housing, and contact with immigrants with high incidence of TB among American-born persons . Davies (2005) found an association between HIV/AIDS, genetics, where people live and work and TB infection. Marsh, Gordon, Heslop, & Pantazis (2000), and Northridge, Ramirez, Stingone and Claudo (2010) found evidence linking housing and health status. Moreau et al. (2012) researched the transmission dynamics of TB in a large urban apartment building and three homeless shelters within one-block radius in Edmonton, Alberta, in a multiethnic multicenter inner-city TB outbreak. The researchers determined the transmission of a novel TB strain from

foreign-born populations to Canadian-born populations through under- housed settings serving vulnerable populations, highlighting changing demographics and emerging health concerns among under-housed populations.

This study found in both multiple and logistic regression analyses a negative association between the type of housing/residence and TB and or MDR-TB, suggesting that as housing/residence environment improved, prevalence of TB and MDR-TB declined. However, this relationship was not statistically significant (p = .978; 95% Cl -.154; .150).

Discussion

Understanding the dynamic relationships and influences of these contextual factors in TB and MDR-TB outcomes is essential and crucial in informing public health policy interventions and practices for effective TB and or MDR-TB preventive and management programs. Their levels of influence is consistent with the SEM I used in framing this study and advocates the importance of social environment that defines peoples' health by exerting influences at multiple levels that shape individuals' behaviors and their susceptibility to disease. Dynamic relationships between individual and multilayer bands of social environment facilitate disease transmission. Wilking, Hohle, Velasco, Suckau and Eckmanns (2012), for example, demonstrated how different social factors predispose individuals to the risk of acquiring infectious diseases.

Available literature identifies and defines tuberculosis as a social disease caused by airborne pathogens, that depend on human interaction within the community or at household level for its transmission (CDC, 2015; WHO, 2015)add citation). However, some individuals and communities provide more ideal environment than others for the

transmission to occur. These differences are partly explained by community or house-level ecological influences that promote TB transmission, including poverty, overcrowding, lack of access to preventive healthcare, and other markers of deprivation that exacerbate the severity and prevalence of TB and or MDR- TB. In addition to treatment of TB and or MDR-TB patients, many of the public health agencies collect case-specific demographic information, such as age, gender, site of disease infection, country of origin, and drug-resistance. This focus on individual demographic data, should, however, not neglect the ecological contexts of TB and or MDR-TB disease occurrence. Information on community and or household level and ecological risk factors for contracting TB and development of multidrug-resistant TB, are important for formulation of appropriate TB and MDR-TB prevention strategies. More specifically, behaviors and susceptibility to TB and or MDR-TB are influenced by intrapersonal, interpersonal, social, and physical environmental factors. These multiple influences and their interactions are relevant for understanding health behaviors at individual, community, and organizational levels that may foster or prevent transmission of TB/HIV co-infections and development of multidrug-resistant tuberculosis among foreign-born populations in Houston.

TB/HIV co-infection presents unique challenges because both diseases are medically complex and stigmatizing. Disease associated stigma and knowledge are believed to be associated with patient's willingness to seek early screening and treatment (Sirinapha et al., 2009). The intrapersonal level influences are invariably and catastrophically intertwined among TB/HIV co-infected individuals. Intrapersonal level influences on TB and MDR-TB, and contracting and prevention of TB/HIV among

foreign-born populations in Houston were more likely to include knowledge of disease transmission, attitudes and perception, and social stigma that affect individual behaviors, such as health seeking behaviors, and adherence to treatment regimens. Good general lay knowledge of TB/HIV co-infection, their causes, and treatment is important for both prompt healthcare seeking and adherence to treatment. Hoa, Thornson, Long, and Diwan (2003) found that large proportion of individuals with a cough for more than three weeks, had limited knowledge of the causes, transmission modes, symptoms, and curability of TB. Men had significantly higher knowledge score than women (3.04 vs. 2.55). Better knowledge was significantly related to seeking healthcare and seeking hospital care. More men than women did not take any health care action at all. Prtero, Rubio, and Pasicatan (2002) found that higher education was associated with knowledge about TB, and that family income was not significantly correlated with health seeking behavior among the general population in Metro, Manila, Phillipes. Mark, Deluca, and Walton (2008) found that tuberculosis in the U.S. disproportionately affects the HIV infected, foreign-born, Black, Hispanic, American Indian/Alaska Native, Asian, homeless, incarcerated, alcoholic, diabetic, or cancer patients, male, those aged $\geq$ 44 years, smokers and poor persons. They further found that knowledge about TB transmission and curability was low among a representative U.S. population. Knowledge about lay beliefs of etiology, transmission and treatment of TB and perceptions of the relationship between TB and HIV is important for health seeking behavior and adherence to treatment. Sirinapha et al. (2009) determined that patients with low TB knowledge were more likely to have severe TB disease and to be hospitalized at enrollment, to be treated at national infectious disease referral hospital, and have low HIV knowledge. Patients with low HIV

knowledge were more likely to know a TB patient and have low TB knowledge. The researchers further found that stigma and low disease-specific knowledge were common among HIV infected TB patients and associated with similar factors. Bjune, and Fich (2010) found that while community members in Addis Ababa, Ethiopia, were aware that there is a relationship between TB and HIV, some feared that disclosure of co-infection would predispose them to HIV-related stigma leading to delays in seeking healthcare for TB/HIV co-infected persons. Corell, Lauzardo, and Heurtelou (2004) found among persons of Haitian origin in South Florida the influence of social stigma and fears related to confidentiality of medical status as a disincentive for early screening. Aoron et al. (2004) found that the HIV pandemic is one of greatest challenges facing TB control programs, and determined that body immune suppression brought about by HIV infection increases the risk of reactivation of latent TB infection and rapid progression to active TB disease. The Centers for Disease Control and Prevention study on persons with TB from Vietnam revealed that Vietnamese consider themselves at low risk for TB which reflected low levels of knowledge about risk factors and modes of transmission which could lead to delays in seeking health care (CDC, 2008). The researchers determined that Vietnamese were anxious about being ostracized by friends and the community if they revealed their TB status. The respondents reported that TB is stigmatizing and socially isolating disease and stated that this prevented them from sharing their TB status with other people. Those living with TB/HIV and had no health insurance were more likely to visit traditional health specialist for acupuncture or herbal medicine, or use traditional remedies, and less likely to go to hospital regardless of the severity of the disease.

Interpersonal level influences on TB/HIV outcomes include patient-provider relationships. Improving cross-cultural communication between patients and health providers enhances patient involvement in health decision making, levels of satisfaction, and better healthcare outcomes (van Servellen, 2009). Foreign-born TB/HIV patients potentially face communication barriers with their healthcare providers encounters because of linguistic challenges.

Access to healthcare is crucial in TB/HIV prevention and control programs, which refers to the degree to which individuals and groups are able to obtain appropriate healthcare from healthcare system in a timely manner (Morales, Lara, Kington, Valdez, & Escarce, 2002). Health system and organizations influences pertains to multiple healthcare systems that foreign-born persons have to navigate to access healthcare services in Houston. Influences at this level include provision, accessibility, and utilization of healthcare services, and collaboration between providers for provision of integrated disease management services for co-morbid cases. Health literacy levels and lack of health insurance limits healthcare access among foreign-born TB/HIV patients. This is acerbated by policy level influences pursued by state government limiting expansion of Medicaid programs to low income groups including foreign-born TB/HIV infected populations. Community level influences include social norms, perceptions, and stigmatization associated with TB/HIV by some sections of the foreign-born communities, which in turn influence early screening, and healthcare seeking behavior for TB/HIV co-infected persons, and ultimately treatment outcomes. Girardi et al. (2004) reported a positive association between unemployment and delayed presentation for TB/HIV, and increasing age with late testing for the diseases.

The human right to housing is enshrined in international law, traceable to the Universal Declaration of Human Rights. The right to adequate housing has been reaffirmed, re-defined and elaborated in numerous occasions since 1948 (Thiele, 2002). A key component in this right is the habitability of housing which should comply with health and safety standards. The right to adequate housing, therefore, provides additional tool for promoting healthful housing and living conditions, and protects individual and community health (Thiele, 2002).

Environmental burden of disease associated with inadequate housing has received wide interest. The influx of immigrants to urban areas throughout the United States has raised disquiet among public health advocates about accessibility of safe and affordable housing and the health consequences of poor-quality housing, particularly among the immigrant communities. Litt et al.(2010) in Denver, Colarado study of recently immigrated Mexican families found that 25% of the houses were overcrowded, 44% experienced adverse conditions including dampness, or mold, 28% had pest problems, and 26% had no ventilation potential, all which were associated with respiratory disease infections including tuberculosis. Jacobs et al. (2014) studied health conditions in low income housing renovation project in Washington, DC, and found that general health in adults significantly improved from 59% to 67% (p = .028) with large statistically significant improvements in water dampness problems, cockroaches and rodents, and reduced pesticide use. The researcher concluded that housing renovations improves health and housing conditions and could help reduce health disparities. Sarivalasis et al. (2013) found that screening and adherence to treatment is difficult among asylum

dwellers, and recommended that short courses of closely monitored treatment were necessary for homeless populations.

Many researchers have linked type of housing/residence to TB and or MDR-TB infections (Gao et al., 2013; Sullivan & Ben, 2012; Chant, 2012; Northridge et al., 2010). Khan et al. (2007) found that multidrug-resistant tuberculosis among foreign-born homeless persons was escalating in Toronto, Canada. Ziemle et al. (2013) reported that TB risk factors among people living with HIV/AIDS were urban settings, previous TB history, overcrowded households, and poor accessibility to healthcare. The American Community Survey (U.S. Census Bureau, 2010) found that 13% foreign-born households were overcrowded compared to 2% of overcrowding in the native households.

Houston Department of Health and Human Services Report (2008) summarizes the state of health in the city and documents that health disparities in the city are consequences of poverty, unemployment, lack of educational opportunities, lack of safe and affordable housing, healthcare access, discrimination and racism. Public health and social policy interventions to address TB/HIV co-infection, type of housing, and prevalence of TB and or MDR-TB among foreign-born communities in Houston must tackle the socio-economic dimensions of tuberculosis.

Limitations of the Study

Limitations of my study include: 1) too few observations on TB/HIV co-infections, MDR-TB, and homelessness ; 2) inability to measure some contextual constructs such as drug abuse, and TB/diabetes co-infections; 3) inability to assess potentially important intrapersonal factors in TB/HIV co-infection. Inability to measure some contextual factors due to lack of data, may have undermined the predictive power

of the study model. I only captured information on foreign-born tuberculosis observation cases that received treatment within the city of Houston healthcare facilities. It is possible that there could have been such other TB patients who may have received treatment in the neighboring countries, such as Mexico, and resided in Houston that I may have not been captured in this study. There were also several potential intrinsic and extrinsic factors that were threats to internal and external validity of my study, including: historical events that occurred during TB treatment that may have affected observation cases and influenced outcome variables, such as prior health education may influence MDR-TB outcomes among TB observation cases by adherence and compliance to TB treatment interventions ; differences in biological, psychological, and social processes, such as belief in personal efficacy in TB prevention may trigger psychological responses to bolster the immune system against development of MDR-TB among some observation cases; lack of access to complete information on TB and MDR-TB prevention may affect prevalence rate of and recovery from TB among observation cases, or a combination of these factors may influence the incidence, and prevalence rates of TB and MDR-TB in this population . Differences in physiological development may influence the response to TB treatment such as differences in TB dose treatment responses between female and male TB patients (Sanneh & Pollock, 2010). Potential extrinsic factors may arise from the fact that observation cases eligible for inclusion in my study during the study period may not necessarily be eligible for another study period due to migration. For instance, an individual who received treatment for TB/MDR-TB and covered during the study period and may no longer be residing within Houston, Texas. This may lead to overestimation of my study findings. Use of secondary data may also limit generazability of my study. In

the following section I discuss how healthcare systems and public health practitioners might apply the information generated from my study to improve the lives of foreign-born persons living with TB and or MDR-TB and prevent further escalation ofboth disease conditions.

Recommendations for Action

Public Health Practice

Primary Prevention. Prevention is primary in the effort of controlling and ultimately eliminating TB and MDR-TB in the United States. There is need for coordinated regular screening among high risk TB foreign-born populations for HIV for early detection of TB/HIV co-infection for appropriate treatment as envisaged in the WHO Stop TB and the USA DOT strategies. Screening for TB of all persons intending to settle in the United States, and any person suspected of TB should be followed by public health agencies as provided in the CDC Technical Instructions for the prevention and control of TB, and implementing the Directly Observed Therapy (DOT) for the treatment of TB patients. DOT has shown to lead to significant reductions in the frequency of TB drug resistance, and lapses in tuberculosis treatment (Weis et al., 1994). Noncompliance with DOT is associated with increase in occurrence of poor TB treatment outcomes and accounts for most treatment failures (Burma et al., 1997). Ensuring universal DOT has been observed to improve TB treatment (Bloss et al., 2012), and also provide TB treatment completion rates (Long, & Ellis, 2007). DOT treatment of people in high risk groups, such as HIV and diabetic patients, will prevent reactivation of latent TB. Healthcare facilities should undertake precautions to prevent transmission of TB bacteria

in their facilities by sterilizing air, filters, and respiratory masks using ultraviolet light and isolating TB patients into special rooms.

Culturally sensitive information and educational efforts to address misconceptions about TB and HIV should be part of the TB prevention campaign. Culturally competent information targeting lay knowledge and beliefs on TB etiology, transmission, and treatment should address lay perceptions on the relationship between TB and HIV, and seek to enhance patient health seeking behavior and adherence to TB/HIV treatment interventions. Healthcare education for TB prevention to target men and women in different socio-economic contexts.

Healthcare Systems. Much of the health indicator data used for surveillance of TB exist within healthcare facilities in electronic form. However, there is little exchange of this information among healthcare facilities for more effective and efficient treatment of TB. This is because of health information system interoperability limitations inherent in the health information infrastructure due to existence of different data collection and sharing standards among health institutions (Lombardo and Buckeridge, 2007). There is need to embrace electronic health information at the point of first service entry among TB caregivers to enhance health information system interoperability and exchange/sharing for effective TB/HIV treatment and management as espoused under the American Recovery and Re-Investment Act of 2009 (ARRA,2009) in support of the American Health Information Technology Initiative to advance efficiency and effectiveness of healthcare service delivery through embracing the health data exchange standardization and electronic health record by the healthcare institutions.

Public Health Agency. Houston Department of Health and Human services, Bureau of Tuberculosis is uniquely placed to monitor and track TB and MDR-TB outcomes. The Bureau's outreach programs for TB prevention and management to incorporate HIV and diabetes screening as the two disease conditions may be catastrophically intertwined in the incidence and prevalence of TB among foreign-born and other underserved populations. Socio-economic circumstances to be considered in the design of TB information campaigns and in prioritizing public health interventions. Inter-agency efforts to promote better housing units through renovations of the existing stock and building new ones, where feasible, for foreign-born and underserved communities should be encouraged and championed by the Houston public health agency.

Recommendations for Future Research

I propose future research pathways to encompass the areas of limitations I have cited above in order to improve the validity and generazability of the TB and or MDR-TB study in Houston and the United States.

Recommendation 1. Although I established associations between being diagnosed with HIV, type of housing/residence and TB and or MDR-TB, the statistical non-significance of these relationships and the low amount of variance accounted by the model suggest that my study must have been underpowered for some constructs such as the prevalence of HIV and homelessness among the observation cases. Validation of the model in a much larger sample covering the entire Texas State could improve the statistical power, and the ability to generalize the study findings to other jurisdictions with high TB and MDR-TB prevalence in the United States.

Recommendation 2. Time and cost constraints limited the scope of my ability to evaluate more potential contextual factors in TB and MDR-TB prevalence among foreign-born populations in Houston. I recommend investigation of other potential relationships such as TB/diabetes co-morbidity, drug abuse, and nutritional status highlighted in chapter 1, (Figure 1), to further elucidate the role of other potential risk factors for TB and MDR-TB among foreign-born communities.

Recommendation 3. In my literature review, I identified some potential intrapersonal factors which were not controlled for in my study due to time and cost constraints, including socio- economic status, health literacy, family history, smoking status, housing environmental conditions, overcrowding, and incarceration. Linkage of state TB database could allow inclusion of these intrapersonal influences as additional covariates in the model and thus improve its predictive power.

Recommendation 4. Further research is necessary to characterize TB/HIV stigmatization in different cultural profiles of the foreign-born communities to quantify impact of TB/HIV stigma on TB/HIV diagnostic delay, treatment compliance, morbidity, and development of additional TB/HIV stigma reduction strategies.

Implications for Social Change

In this study, I sought to elucidate risk factors for high TB prevalence and MDR-TB complications among foreign-born Houston Texas in a setting of declining TB and MDR-TB prevalence in the general population. Sufficient understanding of the predictors of TB and or MDR-TB among foreign-born communities is important for the formulation of appropriate public health and social policy interventions for the reduction

and subsequent elimination of TB morbidity, mortality, and associated economiccosts in the United States.

Tuberculosis direct costs, average $134,000 per MDR -TB and $430,000 per XDR TB patient in comparison to $ 17,000 for non-MDR-TB patients. It costs approximately $483,000 to treat one case of XDR-TB in hospital setting, and about $225,000 to treat one case of MDR-TB in similar settings in the United States. Treating drug-resistant TB is generally much lengthier, costlier and may produce more severe adverse outcomes than treating non-drug-resistant tuberculosis. The TB economic cost in the United States is enormous, estimated in 2009 at $ 37.2 billion, including $20.9 billion direct healthcare costs, $7.4 billion in indirect morbidity costs including lost productivity, and $8.9 billion in indirect mortality costs. The U.S. target is to achieve a TB prevalence rate of 1 case/100,000 by 2020 (American Lung Association, 2013; Healthy People 2020, 2014).

Based on the results I presented in chapter 4, TB and or MDR-TB patients may benefit from public healthcare plans that are specifically tailored to their unique TB/HIV co-morbidity status, age group susceptibility to these disease outcomes, and pursuit of social policies for the enhancement of housing and living conditions that meet the needs of TB and MDR-TB susceptible populations. Targeting TB and MDR-TB patients for increased HIV screening, outpatient care and disease management, and health education predicted on risk factors profiles, may improve intervention outcomes and lead to greater patient satisfaction.

Conclusion

Despite the limitations of my study, this is the first unique effort I am aware of to assess risk factors on the prevalence of TB and or MDR-TB among foreign-born population in Houston, Texas. TB/HIV co-infection and type of housing/residence had no significant influence on the prevalence of TB and or MDR-TB among foreign-born populations in Houston. The results of my study, however, indicate association between TB/HIV co-infection, type of housing/residence, prevalence of TB and MDR-TB complications suggesting that prevention of HIV and improving housing living conditions could reduce prevalence of TB and MDR-TB among foreign-born communities. Primary care services in screening for TB and HIV, and tailoring primary care to patient risk profiles could reduce TB and or MDR-TB among high risk segments of these communities. Primary TB prevention practices and early treatment would further benefit TB and MDR-TB reduction programs.

Future research efforts with larger samples, controlling for more covariates, and incorporating additional contextual risk factors could further elucidate the associations between TB/HIV co-morbidity, type of housing/residence and prevalence of TB and MDR-TB among foreign-born populations in Houston and the United States. Assessment of the impact of TB/HIV stigmatization in health seeking behavior and evaluation of the efficacy of potential TB/HIV stigma reduction strategies among foreign-born TB population should be an integral part of the TB reduction effort.

To meet the challenge of preventing, controlling and ultimately eliminating TB and MDR-TB in the United States, healthcare and treatment of TB and MDR-TB patients should not only be appropriate, but also effective irrespective of national origin, linguistic

or cultural backgrounds. This calls for not only addressing linguistic and cultural needs of populations with or at risk for TB and MDR-TB, but also embracing patient-centered disease treatment and management strategies in TB and MDR-TB prevention programs, embracing health information exchange standards and the health electronic record by healthcare institutions to enhance effective and efficient TB treatment interventions, taking time to understand the unique needs of individual patients and what that matters most to them. Discerning what is at stake for the individual patients will invariably elucidate crucial information for patient-centered treatment and individualized management plans. Focusing on the patient and maintaining an open-two-way communication, will foster effective TB and MDR-TB prevention and control programs. Given the past, current and projected TB and MDR-TB burden among foreign-born population in Houston and the United States, better TB and MDR-TB prevention strategies and future research should be explored as integral part of TB and MDR-TB prevalence reduction and ultimate elimination in the United States.

References

Abubakar, I., Zignol, M., & Falson, D. (2013). Drug-resistant tuberculosis: Time for visionary political leadership. *The Lancet Infectious Diseases*, 13(6), 529-539. Retrieved from http://www.sciencedirect.com/science/article/pii/S1473309913700306

Ahmad, O., Boschi-Pinto, C., Lopez, A., Murray, C., Lozano, R., & Inone, M. (2001). Age standardization of rates: A new WHO standard. Retrieved from http://www.who.int/healthinfo/paper31.pdf

Alavi, S. M., Nadimi, M., Shokri, S., & Zamani, G. A. (2010). Latent tuberculosis infection in individuals with Human Immodeficiency Virus infection: Comparison of tuberculin test to the anti-TB-lgm antibodies. *Pakistan Journal Medical Sciences, 26*(1), 11-14. Retrieved from http://pjm.com.pk/index.php/pjms

American Lung Association (2013). Trends in tuberculosis morbidity and mortality. Retrieved from http://www.lung.org/finding-cures/our-research/trend-report/TB-Trend-Report.pdf

American Recovery and Investment Act (2009). Retrieved from http://www.fcc.gov/American-recovery-investment-act-2009.

Aoron, L., Saadoun, D., Calatroni, I., Launay, O., Memain, N., Vincent, V.,… Lortholary, O. (2004). Tuberculosis in HIV infected patients: A comprehensive review. *Clinical Microbiology and Infection, 10*(5): 388-398. Retrieved from http://onlonelibrary.wiley.com/doi/10.1111/j.1469-0691-2004.00758.x/full

Anderson, R.N., & Rosenberg, H.M. (1998). Report of the second workshop on age adjustment. National Center for Health Statistics. *Vital Health Statistics 4*(30). Retrieved from http://www.cdc.gov/nchs/data/series/sr_04/sr04_0.30pdf

Andrew, S. J., Shah, N. S., Weisman, D., Moll, A. P., Friedland, G., & Gland, N. (2010). Predictors of multidrug and extensively drug-resistant tuberculosis in high HIV prevalence communities. *PloS ONE, 5*(12): e15735.doi: 10.1371/Journal.pone.0015735

Balakrishnan, S., Vijayan, S., & Subramoniapillai, J. (2012). Diabetes prevalence among tuberculosis cases in Kerela, India. *PloS ONE, 7*(10): 1-7. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

Balcaza, H., Wise, S., Rosenthal, L., Ochoa, C., Rodriguez, J., Hastings, D., … Duate-Gardea, M. (2012). An ecological model using Promotores de Salud to prevent cardiovascular disease on the U.S.-Mexico Border; Retrieved from http://www.cdc.gov/pcd/issues/2012/11_0100.htm).

Baral, S. L., Karki, D. K., & Newell, J.N. (2007*).* Causes of stigma and discrimination associated with tuberculosis in Nepal: A qualitative study. *BMC Public Health, 7: 211.doi:*10.1186/1471-2458-7-211.

Baral, S., Logie, C. H., Grosso, A., Wirtz, A., & Beyrer, C. (2013). Modified social ecological model: A tool to guide the assessment of the risk and risk contexts of HIV epidemics. *BMC Public Health, 13:482.doi:*10.1186/1471-2458-13-482.

Baker, M. A., Harries, A. D., Jeon, G.Y., Hart, J.E., Kapur, A., Connroth.,… Murray, M.B. (2011). The impact of diabetes on tuberculosis outcomes: A systematic review. *BMC Med 9: 81.doi:*10.1186/1741-7015-9-81.

Black, T.R. (1999). Doing quantitative research in the social sciences: An integrated approach to research design, measurement, and statistics. Thousand Oaks, CA: SAGE Publications, Inc.

Bloss, E., Chan, P. C., Cheng, N. W., Wang, K. F., Yang, S. L., & Ceqielski, P. (2012).Increasing directly observed therapy leads to improved tuberculosis treatment outcomes in Taiwan. *Int J Tuberc Lung Dis,* 16(4): 412 – 417. Retrieved from *http://www.ncbi.nlm.nih.gov/pubmed122640572*

Biau, D. J., Kerneis, S., & Porcher, R. (2008).Statistics in brief: The importance of sample size in the planning and interpretation of medical research. *Clin Orthop Relat Res,* 466(9): 2282-2288.doi:10.1007/s11999-008-0346-9.

Bronfenbrenner, U. (1994). Ecological models of human development. Retrieved from http://www.psy.cmc.edu/~ziegler/35bronfebrenner94.pdf

Burman, W.J., Cohn, D. L., Rietlmeijer, C. A. Judson, F. N., Sbarbaro, J. A. & Reves, R. R. (1997). Noncompliance with directly observed therapy for tuberculosis: Epidemiology and effects on the outcome treatment. *Chest Journal,* 111(5): 1168 – 1173. Retrieved from *http://journal.publications.chestnet.org/article.aspx?articleid=1070559*

Butler, R., & Carr, J. (2013). Tuberculosis: Department of molecular virology and Microbiology. Baylor College of Medicine. Retrieved from http://www.bcm.edu/molvir/tubeculosis

Cargo, M., Marks, E.,Brimblecombe, J., Scrlett, M., Maypilama, E., Dhurrkay, J.G.,& Daniel, M. (2011). Integrating an ecological approach into Aboriginal

community-based chronic disease program: A longitudinal process evaluation. *BMC Public Health, 11:299.doi:*10.10.11.1186/1471-2458-11-299

Centers for Disease Control and Prevention. (2013a).Self-Study Modules on tuberculosis: patient adherence to TB treatment. Retrieved from http://www.cdc.gov/tb/education/ssmodules/module9/ss9reading.htm

Centers for Disease Control and Prevention. (2013b). The Tuberculosis Behavior Science Research Forum Proceedings. Retrieved from *http://www.cdc.gov/tb/topic/reseaerch/behavioral/proceedings/section3/sec3_identification.htm*

Centers for Disease Control and Prevention (2013c). Tuberculosis data and statistics. Retrieved from http://www.gov.tb/statistics

Centers for Disease Control and Prevention. (2013d). Tuberculosis incidence in the United States, 1953 – 2012. Retrieved from http://www.cd.gov/tb/statistics/tbcases.htm

Centers for Disease Control and Prevention. (2013e). Tuberculosis. Retrieved from http://www.cdc.gov/tb

Centers for Disease Control and Prevention. (2013f). Basic TB Facts. Retrieved from http://www.cdc.gov/tb/basics/defefault-htm

Centers for Disease Control and Preventio.n (2013g). Latent tuberculosis infection*:* A guide for primary healthcare providers. Retrieved from http://www.cdc.gov/tb/publications/ltbi/pdf/TargetedLTBI.pdf).

Centers for Disease Control and Prevention. (2013h).Self-Study Modules on tuberculosis: patient adherence to TB treatment. Retrieved from http://www.cdc.gov/tb/education/ssmodules/module9/ss9reading.htm

Centers for Disease Control and Prevention (2013j). Tuberculosis in the United States: National tuberculosis surveillance system highlights from 2012. Retrieved from http://www.cdc.gov/tb/statistics/surv/surv2012/default.htm

Centers for Disease Control and Prevention (2012a). Basic TB Facts. Retrieved from http://www.cdc.gov/tb

Centers for Disease Control and Prevention (2012b). Trends in tuberculosis, 2012. Retrieved from http://www.cdc.gov/tb/publications/factsheets/statistics/TBTrends.htm

Centers for Disease Control and Prevention (2012c). The Tuberculosis behavior science research forum proceedings. Retrieved from *http://www.cdc.gov/tb/topic/reseaerch/behavioral/proceedings/section3/sec3_identification.htm*

Centers for Disease Control and Prevention (2010a).Tests for TB. Retrieved from http://www.cdc.gov/tb/topics/testing/default.htm

Centers for Disease Control and Prevention (2010b).Tests for TB. Retrieved from http://www.cdc.gov/tb/topics/testing/default.htm

Centers for Disease Prevention and Prevention (2009a).Tuberculosis disparity between US-Born Blacks and Whites, Houston. Retrieved from http://www.cdc.gov/eid/article/15/6/08-1617_article.htm

Centers for Disease Prevention and Prevention (2009b). Immigration requirements: technical instructions for tuberculosis screening and treatment: Using cultures and

directly observed therapy. Retrieved from http://www.cdc.gov/immigrantrefugeehealth/pdf/tuberculosis_ti/2009.pdf

Centers for Disease Prevention and Prevention (2009c). The social ecological model: A framework for prevention. Retrieved from *http://www.cdc.gov/violenceprevention/overview/social-ecologicalmodel.html*

Centers for Disease Prevention and Prevention (2008). Promoting cultural sensitivity: A practical guide for tuberculosis programs that provide services to persons from Vietnam. Retrieved from www.cdc.gov/tb/publications/guidestoolkit/ethnographicguides/vietnam/chapters/vietnam.pdf

Centers for Disease Prevention and Prevention (2005). Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings. Retrieved from http://www.cdc.gov/mmwr/rr/rr5417.pdf

Centers for Disease Control and Prevention (2014).Social determinants of health. Retrieved from http://www.cdc.gov/socialdeterminants/definitions.html

Centers for Medicaid and Medicare Services (2013), Electronic health records incentive programs. Retrieved from http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/index.html?redirect/ehrincetiveprograms

Chan-Yeung, M., Chan, E., Cheung, A., Dai, D. L, Chu, L. (2010). Prevalence of tuberculous infection and active tuberculosis in old age homes in Hong Kong. *Journal of the American Geriatrics Society,* 549: 1334-1340. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, New Jersey. Lawrence Erlbaum. Retrieved from http://www.irdc.pitt.edu/scneider/p2465.Readings/cohen,%201988%20(Statistical%20Power,%2073-406.pdf

Conwell, D. S., Mosher, A., Khan, A., Sandman, L., Vernon, A., & Horsburgh, R. (2007). Factors associated with loss to follow-up in large tuberculosis treatment trials (TBTC Study 22). *Contemporary Clinical Trials*, 28(3): 288-294. Retrieved from http://www.sciencedirect.com.ezp.waldenulibrary.org

Cooper-Patrick, L., Gallo, J., Gonzales, J., Vu, H., Power, N., Nelson, C., & Ford, D. (1999).Race, Gender, and Partnership in Patient-Physician Relations. JAMA, 282(6): 583-589.doi:10.1001/jama.282.6.583.

Corell, M., Lauzardo, M., & Heurtelou, M.(2004). Cultural feasibility assessment of tuberculosis presentation among persons of Haitian Origin in South Florida. *Journal of Immigrant Health*, 6(2): 63- 69. Retrieved from Links.spinger. com/article/10.1023/13/JOIH.0000019166.80968.70

Crosby, R., DiClemente, R., & Salazar, L. (2006). Research Methods in Health Promotion. San Francisco, CA. Jossey-Bass.

Davies, P. (2005). Risk Factors for Tuberculosis. Cardiothoracic Center, Liverpool. *Monaldi Arch Chest Dis.;* 63(1): 37-46. Retrieved from http://archest.fsm.it/pne/pdf/63/1/pne-1_06davies.pdf http://www.ajt.mh.org/content/80/6/1004.full

Dean, H., and Fenton, K. (2010). Addressing social determinants of health in the prevention and control of HIV/AIDs, viral hepatitis, sexually transmitted

infections and tuberculosis. *Public Health Report,* 125(4); 1 – 5. Retrieved from http://www.ncbi.nim.nih.gov/pmc/articles/PMC2882967

De Lourdes, S., Pouce, M., Vendramini, S., Villa, C, Wysocki, A., Kuyumijian, F., Gazetta, C. (2009). The epidemiological dimension of TB/HIV co-infection. *Ravista Latino-American de Enfermagem*, 17(5): 683 – 688. Retrieved from http://www.scielo.br/scielo.php?script=sci_serial&pid=0104.1169&lng=en&nrm=iso

De Perio, M., Niemeir, R., & Niemeier, M. (2013). TB exposure among immigrant employees. *American Jails,* 27(1): 24-28. Retrieved from http://web.ebscohost.com.ezp.waldenulibrary.org/eh

Deresinski, S. (2012). TB in the US—things continue to improve, but there is a long road a head. *Infectious Disease Alert,* 31(8): 85-87. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh

Deribew, W., Deribe, K., Reda, A., Tesfaye, M., Hailmichael, Y., Maja, T., & Colebunders, R. (2013). BMC Public Health, 13 : 408. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/ed

Dreek, A., Michelmore, J., & Teede, H. (2009). The effects of gender, and age on health related behavior. *BMC Public Health*, 19: 213. Retrieved from http://web.ebscohost.com.ezp.waldenulibrary.org/eh

Ellis, P. (2010). The Essential Guide to Effect Sizes: Statistical Power, and the Interpretation of Research Results. New York, NY. Cambridge University Press.

Erdferlder, E., Faul, F., & Buchner, A. (1996). G*Power: A general power analysis program. Behavioral research methods, instruments, and computers; 28(1): 1 -11. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/17695343

Fagard, R., Staessen, J., & Thijs, l. (1996). Advantages and disadvantages of meta-analysis. *J Hertens;* 14(2): S9 – 12; S13. Retrieved from http://www.ncbi.hlm.nih.gov/pubmed/8934372

Faul, F., Erdfelder, E., Lang, A., & Buchner, A. (1996). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/17695343

Faul, F., Erdfelder, E., Buchner, A., & Lang, A-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods,* 41, 1149 – 1160. Retrieved from http://www.gpower.hhu.de/en.html

Ferre, A., Fuhrman, C., Zureik, M., Chonaid, C., Vergnenengre, A. (2012). Chronic bronchitis in the general population: Influence of age, gender, and socio-economic onditions. *Respiratory Medicine,* 106(3): 467-47.1. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:

Feske, M., Teeter, L., Musser, J., & Graviss, E. (2011). Including the third dimension: A spatial analysis of TB cases in Houston/Harris County. *Texas Tuberculosis Research Symposium*, 91(1): S24-S33. Retrieved from http://www.sciencedirect.com.ezp.waldenulibrary.org/science/article/pii/S147297921100

Fewell, Z., Smith, G., & Sterne, J. C. A., (2005). The impact of residual and unmeasured confounding in epidemiologic studies*: A Simulation study. American Journal of Epidemiology,*166(6):646-655.Retrievedfrom http://aje.oxfordjournals.org/content/166/6/646.full

Field, A. (2009). Discovering Statistics Using SPSS (3rd ed.). Thousand Oaks, CA. SAGE Pub.

Frankfort-Nachmias, C. & Nachmias, D(2008). Research methods for social sciences (7th ed.). New York, NY. Worth Publishers

Gao, J., Zheng, P., & Fu, H. (2013). Prevalence of TB/HIV co-infection in countries except China: A systematic review and meta-analysis. PLoS ONE, 8(150):e64915.doi:10.1371/journal.pone.00644915.

Garcia, D.A. (2004). Zip code level risk factors for tuberculosis: Neighborhood environmental and residential segregation in New Jersey (1985-1992). *AM J Public Health;* 26(1): 7-21. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1446660/11344881.pdf

Gargioni, G. (2009). Role of communities in tuberculosis care and prevention. Tuberculosis- Chapter 4. Retrieved from http://www.sciencedirect.com.ezp.waldenulibrary.org/science/article/pii/B978141603988

Garfein, Z., Laniado-Laborin, R., Rodevell, T., Lozada, R., & Deiss, R. (2010). Latent tuberculosis infection persons at risk

for infection with HIV. *Energy Infectious Diseases, 16(5):Doi:10.3201/eid/605.9144*.6.

Gebremarian, M., Blune, G.,& Frich, J. (2010). Lay beliefs of TB and TB/HIV co-infection in Addis Ababa, Ethiopia: A qualitative Study. BMC research notes, 2011, 4:277 doi:10.1186/1756 – 0500-4-277.

Girardi,E., Alois, M., Arici, C., Pezzotti, P., Serraino, D., Balzano, R., & Vigevani, G. (2004). Delayed presentation and late testing for HIV: Demographic and behavioral risk factors in multicenter study in Italy. JAIDS, 36(4): 951 – 959. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15220702

Glanz, K., Rimer, B., & Viswanath (2008). Health Behavior and Health Education. Theory, Research, and Practice (4th ed.). San Francisco, CA. Jossey-Bass.

Goswami, N., Gadkowski, L., Piedrahita, C., Bissette, D., Ahearn, M., Blain, M.,… Stout, J. (2012). Predictors of latent tuberculosis treatment initiation and completion at a U.S. Public health clinic: A prospective cohort study. *BMC Public Health,* 12(1): 468-475. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh

Gupta, D., Das, K., Balmughesh, T., Aggarwal, A., & Jindal, S.(2003). Role of socioeconomic factors in Tuberculosis Prevalence. *Indan J Tuberc.,* 51:27-31.Retrieved from http://medind.nic.in/ibr/104/i1/ibrt04i1.p27.pdf).

Hansel, N., Merriman, B., Haponik, E., & Dette, G. (2004). Hospitalization for tuberculosis in the United States in 2000: Predictors of in-hospital mortality. *Chest,* 126(4): 1079-1086. Retrieved from http://wwww.ncbi.nlm.nih.gov/pubmed/15486367

Healthy People 2020 (2014). HP2020 Objectives. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/objeciveslist.aspx?topicId=23

Healthy People 2020 (2013). Determinants of Health. Retrieved from http://www.healthypeople.gov/2020/about/DOHAbout/

Horne, D, Camp, M., Ortiz, J., Oren, E., Arentz, M., Crothers, K., & Narita, M. (2012). Association between smoking and latent TB in the United States: An analysis of NHANES.*PloS ONE 7(11):e49050.Doi:1o.1371/Journal.pone.0049050.*

Houston Department of Health and Human Services(2008). The City of Houston Health Disparities Data Report. Retrieved from http://www.houstontx.gov/health/disparity.pdf

Houston Department of Health and Human Services (2013a). Bureau of Tuberculosis. Tuberculosis Factsheet.

Houston Department of Health and Human Services (2013b). People living with HIV in Houston in 2011. Retrieved from http://www.houstontx.gov/health/HIV-STD/2013_Epi_Profile%20--APPROVED--05-9-13.p

Howell, D. C. (2012). Treatment of Missing Data---Part 1. Retrieved from http://www.uvm.edu/~dhowel/StatPages/More_Stuff/Missing_Data/Missing.html

Institute of Medicine (2003a). Unequal treatment: What healthcare system administrators need to know about racial and ethnic disparities in healthcare. Retrieved from http://www.iom/edu/media/Files/Report/%20Files

Institute of Medicine (2003b). *The Future of Public's Health in the 21st Century.* Retrieved from *http://www.nap.edu/openbook.php?record_id=10548&page=52*

Institute of Medicine (2009) *America's Uninsured Crisis: Consequences for Health and Health.* Retrieved from http://www.iom.Edu/Reports/2009/Americas-Uninsured-Crisis-Consequences-for-Health-and-Health-Care.aspx

John, B., & Lynch, M. D. (2013). Multidrug resistant tuberculosis. *Med Clin N AM,* 97(4): 553-579. Retrieved from http://www.sciencedirect.com.ezp.waldenulibrary.org/

Kelder, J.A. (2005) Using One Else's data: Problem, Pragmatics, and Provision Forum. *Research;* 6(1): 1 – 13. Retrieved from http://content.ebscohost.com.ezp.waldenulibrary.org/

Kaiser Family Foundation (2013). The President's Emergency Plan for AIDS Relief (PEPFAR). Congressional Digest, 86(7): 195-197. Retrieved from http://kff.org/global-health-plicy/fact-sheet-the-u-s-president-emergency-plan-for-aids

Kanervisto, M., Vasankari, T., Laitenen, T., Heliovaara, M., Jousilahti, P. (2011). Low socio-economic status is associated with chronic obstructive airway disease. *Respiratory Medicine,* 105(8): 1140-1148. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

Katz, M. H. (2006). Multivariate analysis: A practical guide for clinicians. Retrieved from http://books/google.com/books/about/Multivariable_Analysis/html?=fobxcia5831c

Kaye, D. (2010). Mortality among patients with tuberculosis and associations with HIV status-US- *Clinical Infectious Disease,* 52(4):pi-i.1/3p. Retrieved from http://web.ebscohost.com.ezp.waldenulibrary/eh

Kemper, C. (2012). Half of the U. S. TB cases in four states. Infectious disease alert, 31(9); 106-106. Retrieved from http://web.ebscohost.com.ezp.waldenulibrary.org/eh

Kendell, A. (2012). U.S. Response to the global threat of tuberculosis: Basic facts. congressional research service. Retrieved from http://ehis.ebscohost.com.ezp.waldenulibrary.org/ed:

Khan, K., Rea, E., Mcdermaid, C., & Staurt, R. (2007). Active tuberculosis among homeless persons, Toronto, Ontario, Canada, 1998 – 2007. *Emerging Infectious. Diseases*, 17(3): 357 – 365. Retrieved from http://wwwnc.cdc.gov/eid/article/17/3/10-0833_article

Lamorte, W. (2013). Advantages and disadvantages of cohort studies. Boston University School of Public Health. retried from http://sphweb.bumc.bu.edu/otil/

LaTour, K., & Eichenwald-Maki, S. (2006). Health Information Management: Concepts, Principles, and Practice (2nd ed.). Chicago, IL. American Health Information Management Association.

Law, M.(2005). Reduce, Reuse, Recycle: Issues in Secondary use of Research Data. IASSIST Quarterly Spring 2005. Retrieved from http://www.iassistdata.org/downloads/iqvol291law.pdf

Litt. J., Cynthia, W., Diao, L., & Allshouse, A. (2010). Housing environment and child health conditions among recently mexican immigrant families: A population-based study. *Journal of Immigrants and Minority Health*, 12(5): 617 – 619.Retrieved from http://link.spinger.com/article/10.1007%Fs10903-009-9261-8

Liu, Y., Weinberg, M., Ortega, L., Painter, J., & Maloney, S. (2009).Overseas screening for tuberculosis in U.S-bound immigrants and refugees. *New Eng J Med., 360(23):24606-2415*. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

LoBue, P., Cass, R., Lobo, D., Moser, K., & Catanzaro, A. (19990. Development of housing programs to aid in the treatment of tuberculosis in homeless individuals: A pilot study. *Chest* 115: 218 – 223. Retrieved from http://search.proquest.com.ezp.waldenulibrary.org/pii

Lombardo, J., & Buckeridge, D. (2007). Disease Surveillance: A Public Health Informatics Approach. Danvers, MA. John Wiley & Sons, Inc.

Long, R., & Ellis, E.(2007). Introducing the Canadian Tuberculosis Standards 6th edition. *Canadian Respiratory Journal,* 14(6): 327 – 328. *Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC26764003)*

Low, Chien-Tat., Lai, Poh-Chin., Tse, Wing-Sze, C., Tsui, Chung-Kan-., Lee, H., & Hui, Pak-Kwan (2013). Exploring tuberculosis by type of housing development. *Social Science & Medicine*; 87: 77-83. Retrieved from http://www.sciencedirect.com.ezp.waldenulibrary.org/

Mark, S., Flood, J., Seaworth, B., & Hirschmoverman, Y.(2014). Treatment practices, outcomes, and costs of multidrug-resistant and extensively drug-resistant tuberculosis, United States, 2005-2007.*Emerging Infectious Disease Journal*, Vol. 20., May 2013.Retrieved from http://www.cdc.gov/eid/article/20/5/13-1037_article

Marshall, G., & Jonker, L. (2010). Concise guide to descriptive statistics. *Synery:*22-25. Retrieved from http://searchproquest.com.ezp.waldenulibrary.org

McHugh, M. (2003). Descriptive Statistics, Part 11: Commonly used Descriptive Statistics. *JSPN*; 8(3). Retrieved from http://web.ebscohost.com.ezp.waldenulibrary.org

Meda, Z., Sombie, I., & Sanon, O. (2013). Risk factors of tuberculosis infection among HIV/AIDS patients in Burkina Faso. AIDS research and human retroviruses, 29(7): 1045 – 1055. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3685687

Medico, G., Gilman, R. H., Cabrera, L., Kacena, K., Dia'z, Z.F, et al. (n.d). Community infection ratio as an indicator of tuberculosis control. *The Lancet,* 345(8947): 416-419. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:

Menzies, H., Winston, C., Holtz, T., Cain, K., & Mac Kenzie, W. (2010). Epidemiology of tuberculosis among foreign-born children and adolescents in the United States,

1994-2007. *American Journal of Public Health;* 100(9): 1724-9. Retrieved from http://ehis.ebscohost.com.ezp.waldenulibrary.org/eds/details?vid=10&hid=102&

Metcalfe, J., Porco, T., Westenhouse, J., Damesyn, M., Face, M., Hill, J.,.. Flood, J. (2013). Tuberculosis and HIV Co-infection, California, USA, 1993 – 2008. *Journal of Emerging Infectious Diseases*, 1993): 400 – 406. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:

McLeroy, Steckler, Bibeau and Blanz (1988). The Social ecology of health promotion Intervention. Retrieved from http://www.acha.org/healthycampus/ecological_model.cfm

Mitruka, K., Winston, C., & Navin, T.(2012). Predictors of failure in timely tuberculosis treatment completion, United States. *Int J Tuberculosis Lung Dis.,* 16(8): 1075-1082.doi: 10.5588/ijtld.11.0814.

Morales, L., Lara, M., Kington, R., Valdez, R., & Escarce, J. (2002). Socio-economic, cultural, and behavioral factors affecting Hispanic health outcomes. *J Healthcare Poor Underserved*, 13(4): 477 – 503. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/article/PMC1781361

Moreau, D., Gratrix, J., Kunimoto, D., Beckon, A., & Der, E. (2012). A Shelter-Assisted Tuberculosis Outbreak: A novel Strain introduced through Foreign-born Population. Canadian Journal of Public Health, 103.6:e408 – 12. Retrieved from http://search.proquest.com.ezp.waldenulibrary.org/pii

Munro, B.(2005). Statistical Methods for Health Care Research (5th ed.).Philadelphia, PA. Lippincott Williams &Wilkins.

Munsiff, S., Li, J., Cook, S., Piatek, A., Laraque, F., Ebrahinzadeh, A., & Fujiwara, P. (2006). Trends in drug-resistant *Mycobacterium* tuberculosis in New York, 1991-2003. *Clinical infectious Diseases,* 42(12):1702-1710. Retrieved from http://ehist.ebscohost..com.ezp.waldenulibrary.org/ed:

Myers, J. & Sepkowitz, Z. (2008). HIV/AIDS and TB. *International Encyclopedia of Public Health 2008:* 421-430. Retrieved from http://www.sciencedirect.com.ezp.waldenulibrary.org/

Nahid, P., Horne, D., Jarlsberg, L., Reiner, A., Osmond, D., Hopewell, P. C., & Bibbin-Domingo, K. (2011). Racial differences in tuberculosis infection in the United States communities: the coronary artery risk development in young adults study. *Clinical Infectious Diseases*, 53(3): 291 – 294. Retrieved from http://web.ebscohost.com.ezp.waldenulibrary.org/eh

National Institutes of Health(2012a). Tuberculosis factsheet. Retrieved from http://www.nim.nih.gov/medlineplus/tuberculosis.html

National Institutes of Health(2012b). Tuberculosis prevention. Retrieved from http://niaid.nih.gov/Pages/prevention.aspx

National Institutes of Health(2012c). Tuberculosis transmission. Retrieved from http://niaid.nih.gov/Pages/transmission.aspx

National Institutes of Health(2012d). Tuberculosis symptoms. Retrieved from http://niaid.nih.gov/Pages/symptoms.aspx

National Institutes of Health(2012e). Tuberculosis diagnosis. Retrieved from http://niaid.nih.gov/Pages/diagnosis.aspx

National Institutes of Health(2012f). Tuberculosis treatment. Retrieved from http://niaid.nih.gov/Pages/treatment.aspx

National Institutes of Health (2012g). Tuberculosis in Asia and the pacific: The role of socio-economic status and health systems Development. *Int J Prev Med., 3(2):8-16. Retrieved from, http://www.ncbi.nim.nih.gov/pmc/articles/PMC32788731*

National Institute on Drug Abuse [NIDA] (2013). Drug abuse. Retrieved from http://www.drugabuse.gov/

Novignon, J., & Nonvignon, J. (2012). Socio-economic status and prevalence of fever in children under age 5: Evidence from four sub-Saharan African counties. *BMC Research Notes,* 5: 380. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

O'Carrol, P., Yasnoff, W., Ward, M., Ripp, L., & Martin, E.(2003). Public Health Informatics and Information Systems. New York, NY. Springer Science + Business Media.

Ocheretina, O., Morose, W., Gauthier, M., Joseph, P., D'Meza, R., Ezcuyer, V.(2012). Multi-resistant tuberculosis in Port-au-Prince, Haiti. *Revista Panamericana de Salud Publica, 31(3): 221-224*. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:

Olson, N., Davidow, A., Winston, C., & Sanon, O. (2012). A National study of socio-economic status and tuberculosis rates by country of origin in the United States. *BMC, Public Health:* 12:365.Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/detai?vid=3&sid=5de490a2-af

Oren, E., Winston, C., Pratt, R., Robison, V., & Narita, M. (2010). Epidemiology of urban Tuberculosis in the United States, 2000-2007. *AM J. Public Health; 101(7):): 1256-63.* Retrieved from http://ehis.ebscohost.com.ezp.waldenulibrary.org/eds/resultsadvanced?sid=071d3158-55bd-4268-a972-783d8df067

Page, K., Manabe, Y., Adelakuo, A., Federline, L., Cronin, W., & Dorman, S. (2008). Timing of therapy for latent tuberculosis infection among immigrants presenting to A U.S. public health Clinic: a retrospective study. *BMC Public Health*, 8: 158 – 164. Retrieved from http://web.ebscohost.com.ezp.waldenulibrary.org/eh

Parwal, C., Kaushik, A., Makkah, N., Banavaliker, J., Hanif, M.(2013). Incidence and risk factors for extremely drug-resistant tuberculosis in Delhi Region. e55299. *PloS ONE 8.2.* Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

Perri, B., Proops, D., Moonan, P., Munsiff, C., & Ahuja, S. (2011). *Mycobacterium tuberculosis* cluster with developing drug resistance New York, New York, USA. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh

Pettit, A., Bethel, J., Hirsch-Moverman, Y., Colson, P., & Sterling, T. (2013). Female sex and discontinuation of isoniazid due to adverse effects during the treatment of latent tuberculosis. *Journal of Infection*, 67(5): 424-432. Retrieved from http://www.sciencedirect.com.ezp.waldenulibrary.org/

Pratt, R., Winston, C., Kammerer, J., & Armstrong, L. (2011). Tuberculosis in older adults in the United States, 1993-2008. *Journal of the American Geriatrics Society*, 59(5): 851-857. Retrieved from http://web.ebscohost.com.ezp.org/eh

Rajam, R., & Muhammad, G. (2013). A Study of HIV co-infection among pulmonary tuberculosis patient at a private medical college hospital. Asian *Medical Journal*, 13(6): 1 – 11. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

Randal, D. M., & Fernandez, M.F.(1991).The Social Desirability Response Bias in Ethics Research. *Journal of Business,* 10(11):805-817. Retrieved from http://link.spinger.com/artile/10.1007/BF00383696#page-1

Redding, C., Rossi, J., Rossi, S., Wayne, F., & Prochaska, J. (2000) Health behavior models. Accessed a*t http://drzaius.ics.ucl.edu/meta/classes/informatics/6*

Reed, G., Choi, H. Lee, S., Lee, M., Kim, Y., Park, H.,… Kornfeld, H. (2013). Impact of diabetes and smoking on mortality in tuberculosis. *PLosONE, 8(2): 1-8.* Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh

Reis-Santos, B., Locatelli, R., Horta, B., Faerstein, E., Sanchez, M., Riley, L., & Maciel, E.L. (2013). Socio-demographic and clinical differences in subjects with tuberculosis with and without diabetes mellitus in Brazil – A multivariate Analysis. *PLosONE,* 8(4), 1-6. Retrieved from http://webebscohost.com.ezp.waldenulibrary.org/eh

Restrepo, B., Carmelin, A., Rahbar, M. H., Wang, W., Restrepo, M. A. (2011). Cross-sectional Assessment Reveals High Diabetes Prevalence Among Newly Diagnosed Tuberculosis Cases. *Bulletin of the World Health Organization,* 89(5), 352-359. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:

Richard, L., Lehoux, P., Breton, E., Denis, J-L., Labrie, L., & Leonard, C. (2004). Implementing the ecological approach in tobacco control programs: Results of a case study. Evaluation and Program Planning 27 (2004): 409 – 421. Retrieved

from http://www.getoss.enap.ca/GETOSS/Publications/Attachments/136/implimenting%20the%Ecological%20Approach%20in%Tobacco%20Control%20Programs.pdf

Richard, L., Lehoux, P., Breton, E., Denis, J-L., Labrie, L., & Leonard, C. (2004). Implementing the ecological approach in tobacco control programs: results of a case study. Evaluation and program planning 27 (2004): 409 – 421. Retrieved from http://www.getoss.enap.ca/GETOSS/Publications/Attachments/136/implimenting%20the%Ecological%20Approach%20in%Tobacco%20Control%20Programs.pdf

Roberts, C., Lobato, M., Bazerman, L., Kling, R., Reichard, A., & hammett, T. (2006). Tuberculosis prevention and control in large jails: A challenge to tuberculosis elimination. *American Journal of Preventive Medicine,* 30(2): 125-130. Retrieved from http://www.sciencedirect.com.ezp.waldenulibrary.org

Sahly, H., Teeter, C., Pawlak, R., Musser, J., & Graviss, E. (2006). Drug-resistant tuberculosis: a disease of target populations in Houston, Texas. *J infection, 53(1): 5-11.* Retrieved from http://www.sciencedirect.com/science/article/pii/S0163445305003002

Sanders, D., Olive, D., Wallace, S., Lacy, D., Leyba, R., & Kendig, N. (2001). Tuberculosis screening in the federal prison system: An opportunity to treat and prevent tuberculosis in foreign-born populations. *Public Health Reports,* 116(3):210-218. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

Sarivalasis, A,. Bodenmann, P., Langenskiold, E., & Lutchmayaflick, C.(2013). High rate of completion of preventive therapy among a sylum seekers in a Swiss canton.

Swiss Medical Weekly, Sep 6, 2013, 14360. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed24018940

Seaworth, B., Field, K., Flood, J. Saliba, J, J., Mase, S., Cronin, K., & Shah, N. (2013). Interruptions in supplies of second-line ant tuberculosis drugs-United States, 2005-2012. *MMWR*, 62(2): 23-26. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh

Shah, S., Cain, K., Marks, S., & Cavanaugh, J. (2010). Mortality among patients with tuberculosis and associations with HIV Status- United States, 1993-2008, MMWR, 59(46): 1509-1513. Retrieved from http://web.ebscohost.com.ezp.waldenulibrary.org/eh

Shah, N., Mase, S., Chorba, T, & Castro, K. (2012). National shortage of isoniazid 300gm tablets. MMWR, 6(50): 1029-1029. Retrieved from http://web.ebscohost.com.ezp.waldenulibrary.org/eh

Jittimanee, S., Sirinapha, N., & Wittikraisak, W. (2009). Social stigma and knowledge of tuberculosis and HIV among patients with both diseases in Thailand. DOI: 10.1371/journal.pone.0006360.

Stahl, D. (2012). Latent tuberculosis infection screening in Minnesota's critical access hospitals. *Minnesota Medicine,* 95(11): 47-50. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:

Stake, R. (1995). *The art of Case Research*. Newbury Park, CA. Sage Publications

Sullivan, T., & Ben, A. (2012). The co-management of tuberculosis and diabetes: challenges and opportunities in the developing world. PLoS Med, 9(&): e1001269.doi:10.1371/journal.pmed.1001269.

Texas Department of State Health Services (2013a). TB statistics. Retrieved from http://www.dshs.state.tx.us/idcu/disease/statistics

Texas Department of State Health Services (2013b). TB surveillance. Retrieved from http://www.dshs.state.tx.us/idcu/disease/tb/programs/jails/annualreport/

Texas Health and Human Services Commission (2014). Refugees and Immigrants Assistance Program. Retrieved from http://www.hhs.state.tx.us/programs/refugees

Thiele, B.(2002). The human right to adequate housing: A tool for promoting and protecting individual and community health American *Journal of Public Health*, 92(5): 712 – 715. Retrieved from http://www.st-va.ncbi.nlm.nih.gov/pmc/articles/PMC1447150

University of Oregon (2013). The Social Ecological Model: A Framework for Prevention. Retrieved from http://90by30.uoregon.edu/socio-ecological-model

U.S. Census (2010). The 2010 Census Summary. Retrieved from http://www.census.gov/prod/cen2010/briefs/c2010-03.pdf

U.S. Census (2010). American Community Survey 2010. Retrieved from http://www.census.gov/prod/2012pubs/acs-19pdf.

Valadas, E., Gomes, A., Sutre, A., Brilha, S., Wete, A., Hanscheid, T., & Antures, F. (2013). Tuberculosis with Malaria or HIV Co-infection in Large Hospital in Luanda, Angola. Journal of Infection in Developing Countries, 7(3): 269 – 272. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

van Servellen, G. (2009).Communication Skills for the Health Care Profession: Concepts, Practice, and Evidence (2nd ed.). Sudbury, MA. Jones and Bartlett Publishers.

Wanyeki, I., Olson, S., Brassard, P., Menzies, D., Ross, N., Behr, M., & Schwartzaman, K. (2006). Dwellings, crowding, and tuberculosis in Montreal. *Social Science Medicine*. Retrieved from http://www.sciencedirect.com.ezp.waldenulibrary.org

Warkentin, J., Flood, J., True, L., Kanouse, J., Shah, N., Mase, S.,… Chorba, T. (2013). Impact of a shortage of first-line ant tuberculosis medication of tuberculosis control …United States, 2012- 2013. *MMWR,* 62(20): 398-400. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh

Weis, S., Slocum, D., Blais, F., King, B., Wunn, M., Matney, B.,.. Foresman, B. (1994). The effect of directly observed therapy on the rates of drug resistance and lapse in tuberculosis. *New England Journal of Medecine,* 330:1179 – 1184. Retrieved from http://www.yale.edu/intmed/resources/docs/weis.pdf

Winston, C., & Navin, T. (2010). Birth cohort effect on latent tuberculosis infection prevalence, Unites States. *BMC Infectious Diseases,* 10(1):206-209. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:

World Health Organization (2013a). Tuberculosis. Retrieved from http://www.who.int/mediacentre/facsheets/fs104/en/inde.html

World Health Organization (2013b). The Ecological Framework. Retrieved from http://www.who.int/violenceprevention/approach/ecology/en

World Health Organization (2004). The Stop TB Strategy: A TB Free World. Retrieved from http://www.who.int/tb/strategy/stop_tb_strategy/en/htm

Woodruff, R., Winston, C., & Miramonte, R. (2013). Predicting U.S. tuberculosis case counts through 2020. PLOs one, 8(6): 1-7. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh

Wu, J., & Dalal, K. (2012). Tuberculosis in Asia and the Pacific: the role of socioeconomic status and health system development. *Int J Prev. Med,* 3(1): 8-16. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed

Yin, R. (1989). Case Study Research: Design and Methods (1st ed.). Beverly Hills, CA. Sage Publishing.

Young, F., Critchey, J., & Enwin, N. (2009). Diabetes and tuberculosis: a dangerous liaison and no white tier. *Indian Journal of Medical Research*, 130(1): 1-4. Retrieved from http://web.ebscohost.com.ezp.waldenulibrary.org/eh

Appendix A: Tuberculosis Trends and Facts in the United States

***Table A1**: Tuberculosis Cases, Case Rates/100,000 Population, Deaths, and Death Rates/100,000 Population and Percent Change: United States, 1953 – 2012*

Year	Tuberculosis Cases				Tuberculosis Deaths			
	Number	Rate	Percent Change		Number[1]	Rate[1]	Percent Change	
			Number	Rate			Number	Rate
1953	84,304	52.6	--	--	19,707	12.4	--	--
1954	79,775	48.9	-5.4	-7.0	16,527	10.2	-16.1	-17.7
1955	77,368	46.6	-3.0	-4.7	15,016	9.1	-9.1	-10.8
1956	69,895	41.4	-9.7	-11.1	14,137	8.4	-5.9	-7.7
1957	67,149	39.0	-3.9	-5.8	13,390	7.8	-5.3	-7.1
1958	63,534	36.3	-5.4	-6.9	12,417	7.1	-7.3	-9.0
1959	57,535	32.4	-9.4	-10.7	11,474	6.5	-7.6	-8.5
1960	55,494	30.7	-3.5	-5.2	10,866	6.0	-5.3	-7.7
1961	53,726	29.2	-3.2	-4.9	9,938	5.4	-8.5	-10.0
1962	53,315	28.6	-0.8	-2.1	9,506	5.1	-4.3	-5.6
1963	54,042	28.6	1.4	0.0	9,311	4.9	-2.1	-3.9
1964	50,874	26.5	-5.9	-7.3	8,303	4.3	-10.8	-12.2
1965	49,016	25.2	-3.7	-4.9	7,934	4.1	-4.4	-4.7
1966	47,767	24.3	-2.5	-3.6	7,625	3.9	-3.9	-4.9
1967	45,647	23.0	-4.4	-5.3	6,901	3.5	-9.5	-10.3
1968	42,623	21.2	-6.6	-7.8	6,292	3.1	-8.8	-11.4
1969	39,120	19.3	-8.2	-9.0	5,567	2.8	-11.5	-9.7
1970	37,137	18.1	-5.1	-6.2	5,217	2.6	-6.3	-7.1
1971	35,217	17.0	-5.2	-6.1	4,501	2.2	-13.7	-15.4
1972	32,882	15.7	-6.6	-7.6	4,376	2.1	-2.8	-4.5

(table continues)

Year	Tuberculosis Cases				Tuberculosis Deaths			
	Number	Rate	Percent Change		Number[1]	Rate[1]	Percent Change	
			Number	Rate			Number	Rate
1973	30,998	14.6	-5.7	-7.0	3,875	1.8	-11.4	-14.5
1974[2]	30,122	14.1	-2.8	-3.4	3,513	1.7	-9.3	-5.6
1975	33,989	15.7	--	--	3,333	1.6	-5.1	-5.9
1976	32,105	14.7	-5.5	-6.4	3,130	1.5	-6.1	-6.3
1977	30,145	13.7	-6.1	-6.8	2,968	1.4	-5.2	-6.7
1978	28,521	12.8	-5.4	-6.6	2,914	1.3	-1.8	-7.1
1979[3]	27,669	12.3	-3.0	-3.9	2,007	0.9	-31.1	-30.8
1980	27,749	12.2	0.3	-0.7	1,978	0.9	-1.4	0.0
1981	27,373	11.9	-1.4	-2.3	1,937	0.8	-2.1	-11.1
1982	25,520	11.0	-6.8	-7.7	1,807	0.8	-6.7	0.0
1983	23,846	10.2	-6.6	-7.4	1,779	0.8	-1.5	0.0
1984	22,255	9.4	-6.7	-7.5	1,729	0.7	-2.8	-12.5
1985	22,201	9.3	-0.2	-1.1	1,752	0.7	1.3	0.0
1986	22,768	9.5	2.6	1.6	1,782	0.7	1.7	0.0
1987	22,517	9.3	-1.1	-2.0	1,755	0.7	-1.5	0.0
1988	22,436	9.2	-0.4	-1.3	1,921	0.8	9.5	14.3
1989	23,495	9.5	4.7	3.7	1,970	0.8	2.6	0.0
1990	25,701	10.3	9.4	8.2	1,810	0.7	-8.1	-12.5
1991	26,283	10.4	2.3	0.9	1,713	0.7	-5.4	0.0
1992	26,673	10.4	1.5	0.1	1,705	0.7	-0.5	0.0
1993	25,103	9.7	-5.9	-7.1	1,631	0.6	-4.3	-14.3
1994	24,205	9.2	-3.6	-4.8	1,478	0.6	-9.4	0.0

(table continues)

Year	Tuberculosis Cases				Tuberculosis Deaths			
	Number	Rate	Percent Change		Number[1]	Rate[1]	Percent Change	
			Number	Rate			Number	Rate
1995	22,727	8.5	-6.1	-7.2	1,336	0.5	-9.6	-16.7
1996	21,210	7.9	-6.7	-7.8	1,202	0.5	-10.0	0.0
1997	19,751	7.2	-6.9	-8.0	1,166	0.4	-3.0	-20.0
1998	18,287	6.6	-7.4	-8.5	1,112	0.4	-4.6	0.0
1999	17,499	6.3	-4.3	-5.4	930	0.3	-16.4	-25.0
2000	16,309	5.8	-6.8	-7.8	776	0.3	-16.6	0.0
2001	15,945	5.6	-2.2	-3.2	764	0.3	-1.6	0.0
2002	15,055	5.2	-5.6	-6.5	784	0.3	2.6	0.0
2003	14,835	5.1	-1.5	-2.3	711	0.2	-10.2	-33.3
2004	14,498	4.9	-2.3	-3.2	662	0.2	-6.9	0.0
2005	14,061	4.8	-3.0	-3.9	648	0.2	-2.1	0.0
2006	13,727	4.6	-2.4	-3.3	644	0.2	-0.6	0.0
2007	13,282	4.4	-3.2	-4.2	554	0.2	-14.0	0.0
2008	12,895	4.2	-2.9	-3.8	590	0.2	6.5	0.0
2009	11,520	3.8	-10.7	-11.4	529	0.2	-10.3	0.0
2010	11,163	3.6	-3.1	-3.8	569	0.2	7.6	0.0
2011	10,517	3.4	-5.8	-6.5	…	…	…	…
2012	9,945	3.2	-5.4	-6.1	…	…	…	…

Source: National Center for Health Statistics, CDC, National Vital Statistics Reports

1 Official tuberculosis mortality statistics were compiled by the National Center for Health Statistics, CDC, National Vital Statistics Reports.

[2] Case data after 1974 are not comparable to prior years due to changes in the surveillance case definition that became effective in 1975.

[3] The large decrease in death rate in 1979 occurred because late effects of tuberculosis (e.g., bronchiectasis or fibrosis) and pleurisy with effusion (without mention of cause) are no longer included in tuberculosis deaths.

Percent change in tuberculosis death rates is calculated with rounded figures.

Table A2: ***Number of TB Cases Reported In the US, Texas, and Houston, 2009-2012***

	2009	2010	2011	2012
Houston only	260	235	227	195
Harris County(including Houston	396	340	318	267
Texas	1,501	1,385	1,325	1,233
USA	11,540	11,182	11,182	9,945

Source: Houston Department of Health and Human Services

Bureau of Tuberculosis Control (Updated July, 2013).

Table A3: ***TB Case Rate/100,000 Population, 2009 – 2012***

	2009	2010	2011	2012
Houston only	11.5	11.7	9.9	8.5
Texas	6.5	6.2	5.1	4.7
USA	4.4	3.6	3.4	3.2

Source: Houston Department of Health and Human Services

Bureau of Tuberculosis Control (Updated July, 2013).

Table A4: ***TB Case by Place of Birth-Houston, 2009 – 2012***

	2009		2010		2011		2012	
	#	%	#	%	#	%	#	%
USA	124	47.7	100	42.8	104	45.8	82	42.1
Outside USA	133	51.1	134	57.0	123	54.2	113	57.9
Unknown	3	1.2	1	0.4	0	0.0	0	0.0
Total	260		235		227		195	

Source: Houston Department of Health and Human Services

Bureau of Tuberculosis Control (Updated July, 2013).

Appendix B

Literature Review Matrix

Reference	Theoretical/ Conceptual Framework	Study Objectives, Research Question(s)/ Hypotheses	Study Population	Methodology (Type of Study)/ Intervention Design (if applicable)	Analysis, Results & Major Findings	Strengths/ Limitations	Conclusions Recommendations	Implications for Future Research	Implications for Practice

Oren, E., Winston, C., Pratt, R., Robison, V., & Narita, M. (2010). Epidemiology of urban tuberculosis in the United States, 2000-2007. *AM J. Public Health*; 101(7): 1256-63. Retrieved from http://ehis.ebscohost.com.ezp.waldenulibrary.org/eds/resultsadvanced?sid=071d3158-55bd-4268-a972-783d8df067	Variation of TB prevalence and incidence in large U.S. cities.	To evaluate the burden of TB in large U.S. cities.	National sample of 48 large cities	Cross-sectional study using NTSS data	Used NTSS data for bivariate and multivariate analyses	Reasonable sample size of 42,448 individual respondents in 48 large cities.	60% of the cities indicated increasing prevalence and incidence of TB.	More studies of city level variations in migration and SES.”.	Requires additional financial resources to improve urban TB control.

Menzies, H. J., Winston, C. A., Holtz, T. H., Cain, K. P., & Mac Kenzie, W. R. (2010). Epidemiology of tuberculosis among foreign-born children and adolescents in the United States, 1994-2007. *AM J. Public Health*; 100(9): 1724-9. Retrieved from http://ehis.ebscohost.com.ezp.waldenulibrary.org/eds/details?vid=10&hid=102&	Variations of incidence of TB between U.S- and Foreign-Born Children and Adolescents.	To investigate trends in TB among U.S- and Foreign-Born Children and Adolescents.	National samples using NTSS from 1994-2007.	Cross-sectional study using NTSS data.	Multivariate analysis. Foreign children and adolescents were 20 time higher as U.S-Born Adolescents	Large national sample	Marked disparities in TB morbidity persist between foreign-born children and adolescents	Research on better pre-immigration on TB screening process	Enhanced post-immigration TB screening process.

Olson et al. (2012). A National study of socio-economic status and suberculosis rates by country of origin in the United States. *BMC, Public Health:* 12:365.Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/detai?vid=3&sid=5de490a2-af	Patterns of socio-economic among U.S- and foreign-born TB patients.	To assess association of SES with TB in the U.S.	National cohort with TB 1996-2007.	Using National TB Surveillance data.	Large sample size, using national TB database.	SES weakly associated with TB among foreign-born persons in the U.S.	SES alone is not sufficient explanation for high prevalence of TB among foreign-born persons in the United States.	More investigation to determine predictors of increasing prevalence and incidence of TM and MDR-TB among foreign-born persons in the U.S.	More effective public health interventions necessary to prevent and control TB and MDR-TB in the United States.

Winston, C. A., & Mitruka, C. (2012). Treatment duration for patients with drug-resistant tuberculosis. *Journal of Emerging Infectious Diseases;* 18(7): 1201-2. .Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/detai?vid=3&sid=5de490a2-af	Variations in treatment duration by drug-resistance pattern.	Evaluate treatment duration by drug-resistance pattern among TB patients	National cohort of TB patients in the United States.	National study using National TB Surveillance data.	Large national sample size.	MDR-TB still a serious public health problem in the United states.	More investigations on effective MDR-TB treatment.	Investigation on the predictors of TB and MDR-TB	Devising more TB and MDR-TB effective preventive and control interventions.

Andrew, S. J., Shah, N.S., Weisman, D., Moll, A. P., Friendl, G., & Gland, N. (2010). Predictors of multidrug- and extensively drug-resistant tuberculosis in high HIV prevalence communities. *PloS ONE, 5(12):e15735.Doi:10.1371/Journal.pone.0015735.*:	Culture and drug-susceptibility Testing (DST)	To identify clinical predictors of drug resistance among HIV CO-INFECTED PATIENTS	Patients with MDR-TB and EDR-TB in high prevalence in South Africa	Retrospective case-control study	Multivariate logistic analysis; EDR-TB strongly associated with history, treatment failure	Strength include cheap and easily available secondary data, while potential clerical errors could be source of limitations	History of prolonged hospitalization, HIV co-infection, and treatment failure are predictors of MDR- and XDR-TB	Need for molecular epidemiological studies to better define transmission in hospitals are needed	Patients previously treated and hospitalized should be considered for empirical second-line TB treatment

Horne, D. J., Camp, M., Ortiz, J.R., Oren, E., Arentz, M., Crothers, K., & Narita, M. (2012). Association between smoking and latent TB in the United States: An analysis of NHANES.*PloS ONE 7(11):e49050.Doi:1o.1371/Journal.pone.0049050.*	National data survey	Evaluate the association between LTBI and smoking in low prevalence settings	1990-2000 population-based data from NHANESS of persons above 20 years old	Self-reported smoking history using questionnaire and serum cot nine measurement	Multivariate logistic regression adjusted for known confounders(age, birthplace, race/ethnicity, poverty, education, history of BCG vaccination and exposure to TB	Large national representative sample of non-institutionalized U.S civilian population; it is limited only to persons more than 20 years of age	Smoking was associated with increased risk of LTBI, and strongest among Mexan-Americans	Need for more research on the association between LTBI and smoking in high TB prevalence settings	Prevention of exposure to smoking should be part of LTBI prevention and control strategy

Alavi, S. M., Nadimi, M., Shokri, S., & Zamani, G. A. (2010). Latent tuberculosis infection in individuals with human immodeficiency virus infection: comparison of tuberculin test to the anti-TB-lgm antibodies. *Pak J Med Sci,* 26(1):11-14. Retrieved from http://ehis.ebscohost.com.ezp.waldenulibrary.org/ed:	Not stated	To determine LTBI prevalence and compare TST results to TB-lgm bodies (ATIA) for diagnosis of LTBI in HIV infected individuals	62 randomized HIV infected participants form an addict treatment center in Ahvaz, South Iran.	Randomized sample study	TST better test for LTBI diagnosis than ATIA	Limited to a relatively small sample size	Prevalence of LTBI was higher among HIV infected individuals than in any other part of the world	Need to replicate the study with a larger sample size	TST Is useful test for LTBI diagnosis

Wiedland, M. L., Weis, J. A. Olney, M. N., Olema'n, M, et al. (2011). Screening for tuberculosis at an Adult Education Center: Results of a Community-Based Participatory Process. *American Journal of Public Health, 101(7):1264-1267.doi:10.2105/AJPH.2010.300024*. retrieved from http://ehis.ebscohost.com.ezp.waldenulibrary.org/ed:	Community-based participatory research (CBPR)	Determine efficacy of community-based approach to TST among immigrants	254 adult learners volunteer in Rochester, Minnesota	Community-based participatory research using focus groups at adult education settings to implement TB education and TST	18.5% of the participants tested TB positive	Community-based participatory approach. Limitation mainly due to the sample size of 254	TST at adult education settings is effective for community TB diagnosis	Need to replicate study with a larger sample size	Participatory approach for TST is effective approach among refugees/immigrants

Garfein, Z.S., Laniado-Laborin, R., Rodevell, T.C., Lozada, R,, Deiss, R, et el. (2010). Latent tuberculosis infection Persons at Risk for Infection with HIV. *Energy Infectious Diseases, 16(5):Doi:10.3201/eid/605.9144*.6.	Not described, but follows eco-ecological model	To evaluate the association between LTBI and HIV	508 IDU, female sex workers and holes persons in Tijuana, Mexico	Questionnaires interviews survey	Strong association between LTBI and HIV among incarcerated and homeless persons	It was a good exploratory research. The size of the sample was the major limitation	Understanding prevalence of LTBI critical in the TB control	Replication of the study for conclusive evidence	Screening for LTBI is critical for TB control programs

Winston, C.A., & Navin, T.R. (2010). Birth cohort effect on latent tuberculosis infection prevalence, Unites States. *BMC Infectious Diseases,* 10(1):206-209. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	Not discussed	Assessment of the birth cohort effects on LTBI prevalence over time	National representative survey data by NHANES surveys (1971-2000)	Weighted data analysis of NHANES survey design (1971-2000)	Weighted data analysis	Large national representative sample over a long time period	Older age groups have higher rates of TB than younger groups, and the prevalence is generally under-estimated	Research one the waning immunologic reactivity and cohort effect among older people	More TB prevention effort focused o older people

Liu, Y., Weinberg, M. S., Ortega, L. S., Painter, J.A., & Maloney, S. A. (2009).Overseas screening for tuberculosis in U.S-Bound immigrants and refugees. *New Eng J Med*., 360(23):24606-2415. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	Not discussed	Study epidemiology of TB in immigrant populations who had been screened overseas with a follow-up evaluation on arrival in the U. S.	3 million U.S-bound immigrants screened by the CDC	Retrospective observational study	Overseas screening for TB with a follow-up evaluation after arrival in the United States. The program is a high yielding intervention for identifying TB in U.S-bound immigrants and refugees.	Large national representative sample	The program could reduce the number of TB new cases among foreign-born resident if well carried out. There is need for more research to determine why persons cleared of TB	Need for research to evaluate risk factors for TB among foreign-born U.S residents once they have been cleared of TB infections both at the overseas screening and follow-up evaluati	Periodic evaluation for TB may help identify latent TB infections among foreign-born U.S. residents

Balakrishnan, S., Vijayan, S., Subramonianpillai, J., Mrithyunjayan, S, et al. (2012). Diabetes prevalence among tuberculosis cases in Kerela, India. *PloS ONE, 7(10):1-7.* Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	State wide data analysis	To determine the prevalence of diabetes mellitus among TB patients	Statewide TB registered patients from Jun-July, 2011 in the State of Kerela, India	Cross-sectional study	50% of the TB patients were co-infected with diabetes mellitus	The strength including Statewide representative sample, while the time period of only two months was not sufficiently adequate to provide temporal variations in the interactions of the two diseases	More than 50% of the TB patients were co-infected with DM. Co-infection is a risk factor for TB.	Need to establish the most cost-effective ways for DM screening through operational research	Routine screening of TB patients for diabetes mellitus is an opportunity for early detection and improved management

Sanders, D. S., Olive, D. M., Wallace, S. B., Lacy, D., Leyba, R., & Kendig, N.E. (2001). Tuberculosis screening in the federal prison system: An opportunity to treat and prevent tuberculosis in foreign-born populations. *Public Health Reports,* 116(3):210-218. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	Syste m wide data analys is	To evaluate risk factors for TB infections among foreign-born inmates	Inmates entering the federal Bureau prison system from February 1,to June 30, 199 at San Diego detention facility	Retrospective cohort study	TST and universal chest radiograph screening inmates; foreign-born inmates were 5.9 times more likely than U.S-born inmates to have TB	Only one State detention facility was used in the analysis	Foreign-born inmates more prune to TB infection, and universal chest radiograp h screening is not superior to TST	More research to understa nd why foreign-born inmates are more prone than U.S-born inmates to TB	Perio dic inmat e scree ning for TB could provi de oppo rtunit y for early detec tion of TB infect ion amon g forei gn-born

Munsiff, S. S., Li, J., Cook, S. V., Piatek, A., Laraque, F., Ebrahinzadeh, A., & Fujiwara, P. I. (2006). Trends in drug-resistant *Mycobacterium* tuberculosis in New York, 1991-2003. *Clinical infectious Diseases*, 42(12):1702-1710. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	Citywide analysis of drug resistance examined separately for incidence and prevalence	To determine TB drug-resistance between foreign-born and U.S-born populations.	251 TB patients in 1991 and 217 in 1994 in New York City	Cross-sectional survey in April in 1997 and April-June 2003	. Drug-resistance decreased from 9% in 1991 to 2.8% in 2003 among U.S-born TB patients, while it increased worrisomely from 9% in 1991 to 23% in 2003	The sample sizes in both periods were relatively low.	Case management including DOTS therapy, adherence monitoring and periodic medical reviews should support TB treatment protocol to reduce drug-resistance	More research to determine the role of case management including DOTS therapy, adherence monitoring and periodic medical review for effective TB treatment.	Intensive case management including DOTS therapy, adherence monitoring, and periodic medical treatment review to

Ocheretina, O., Morose, W., Gauthier, M., Joseph, P. D., D'Meza, R., Ezcuyer, V, et al. (2012). Multi-resistant tuberculosis in Port-au-Prince, Haiti. *Revista Panamericana de Salud Publica,* 31(3): 221-224. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	Nation-wide survey data analysis	Determine multidrug-resistance tuberculosis among patients with new smear-positive pulmonary TB	1006 patients newly diagnosed with TB in Port-au-Prince, Haiti in 2008	Testing of isolates for resistance to first-line anti-bionics	Resistance to isoniazid and rifampin was tested by DST, and multidrug-resistance to first-line drugs was detected	Relatively large sample size	Resistance of 2.9% to isoniazid and rifampin by drug susceptibility test (DST) was found	More research for conclusive determination	Sequencing and hybridization essays are good screening tools for early detection of MDR-TB.

Chan-Yeung, M., Chan, E. H. W., Cheung, A. H. K., Dai, D. L. K., Chu, L. W, et al. (2010). Prevalence of tuberculous infection and active tuberculosis in old age homes in Hong Kong. *Journal of the American Geriatrics Society,* 549: 1334-1340. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	Eco-social model	To assess the prevalence of tuberculosis infections and active TB in old age homes, and determine institutional transmission	2,243 residents representing 84.6% of all residents in 15 old age homes; 1698 were women and 545 were men	Cross-sectional study design	Multivariate analysis. The study determined that prevalence rate of active TB was 6.9%,s significantly higher in men than women. No evidence of institutional TB transmission	Large representative sample	Men experienced higher TB burden in institutional settings than women	More investigation to determine why women were less prone to TB infection than men in institutional settings	TB prevention strategies in old age institutional homes should focus on men

Restrepo, B. I., Carmelin, A., Rahbar, M. H., Wang, W., Restrepo, M. A., et al (2011). Cross-sectional assessment reveals high diabetes prevalence among newly diagnosed tuberculosis cases. *Bulletin of the World Health Organization,* 89(5): 352-359. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	Eco-social model	To estimate the contribution of clinically confirmed diabetes mellitus to TB rates in where both diseases are prevalent to identify opportunities for TB to prevent co-	233 TB suspects more than 20 years of age along Mexican-Texas border (South Texas and North Eastern Mexico)	Prospective study of 20 year olds and above who tested positive to diabetes mellitus at TB clinics in the Texas-Mexico border	Multivariate analysis. Risk of TB attributable to diabetes was 39% in Texas and 36% in Mexico. Diabetes contributed 25% of the TB cases, and HIV infection contributed 5% or fewer	Sample size was relatively small for this type of study.	Patients with diabetes are at higher risk of contracting TB than non-diabetic patients	Need for replication of the study under other settings	Integrating TB and diabetes control programs worldwide would facilitate TB prevention among diabetes patient, leading to early case detection and improvement of management for

Stahl, D. (2012). Latent tuberculosis infection screening in Minnesota's critical access hospitals. *Minnesota Medicine,* 95(11): 47-50. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	Study based on the Centers for Disease Control and Prevention's 2005 *MMWR Guidelines for TB Screening*	To investigate whether critical access hospitals in Minnesota were following the CDC's guidelines for screening and treatment for latent TB infections	74 TB screening and treatment critical access hospitals in Minnesota	Mail or email survey based on the Appendix B of the CDC's 2005 *MMWR*	97% of the hospitals used TST as their baseline test. 29% screened only at hires, and 71% screened annually	Representative sample	Many hospitals do not follow CDC's recommendations, nor do all hospitals refer individuals with positive test results to treatment	Investigate why hospitals are not compliance with the CDC's 2005 *MMWR* recommendations	Screening is most effective when performed on individuals at increased risk for TB and can be useful for early TB detection

Medico, G., Gilman, R. H., Cabrera, L., Kacena, K., Dia'z, Z.F, et al. (n.d). Community infection ratio as an indicator of tuberculosis control. *The Lancet,* 345(8947): 416-419. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed:	Not stated	To investigate the relative importance of within-house and community TB transmission and infection	557 Children aged 6 months and 14 years living in a Peruvian shanty town	Cross-sectional study	Within-house and community TB transmission and infection were analyzed. Living in a contact household and age were significant risk factors for purified protein derivative (PPD) positive	Large participation rate	Age and living in a contact household are risk factors for TB infection	More research for TB control strategies for areas with high community infection ratio (CIR)	Currently recommendated TB control strategies are suitable for areas with low community infection ratio

Wu, J., & Dalal, K. (2012). Tuberculosis in Asia and the Pacific: the role of socioeconomic status and health system development. *Int J Prev. Med,* 3(1): 8-16. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed	Analysis of secondary data	To establish relationship between socio-economic status, health system development and the incidence, prevalence and mortality of TB in Asia and the Pacific	2007 data from 46 countries of the Asian Development Bank Region	Retrospective analysis of 2007 data on incidence, prevalence and 20 variables of socioeconomics, health system and biological behavioral issues were analyzed involving 46 countries in Asia and Pacific region	Univariate and multivariate linear regression analysis. Cambodia, India, and Indonesia were most affect, while Australia was least affected	Large sample size, and many socioeconomic and behavioral factors were controlled for in the model	TB incidence, prevalence, and mortality rate were higher in counties with lower human development index, high corruption perception index, malnourished populations, lower per capita expenditure in health,	Replicate the study in other socio-economic status settings	Socio-economic determinants of health and health system development critical in TB prevention programs

Novignon, J., & Nonvignon, J. (2012). Socio-economic status and prevalence of fever in children under age 5: evidence from four sub-Saharan African counties. *BMC Research Notes,* 5: 380. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed	Demographic and health data analysis	To investigate relationship between socio-economic status and prevalence of fever associated with TB, polio, measles, and diarrhea in children undue age 5	38,990 children undue age 5 from Ghana, Nigeria, Kenya, and Sierra Leone	Secondary data analysis	Multi-level random effects logistic model analysis. Children from weather households reported fewer prevalence of fever associated with TB infections.	Large sample size was the strength of the study, while 3 participating countries were from the Western African Coast and only one from the Eastern Coast was a weakness.	Poverty influencing prevalence of fever related to TB infection.	More studies involving more representative sub-Saharan Africa	Elimination of poverty should be an integral part of TB prevention and prevention program

Kanervisto, M., Vasankari, T., Laitenen, T., Heliovaara, M., Jousilahti, P, et al. (2011). Low socio-economic status is associated with chronic obstructive airway disease. *Respiratory Medicine,* 105(8): 1140-1148. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed	Population-based self report questionnaire study	To determine association between socio-economic status and chronic obstructive airway diseases including TB	A retrospective study of cohort of 6525 aged more than 30 years of age participants in Finland in 2000	Population-based cohort study adjusted for age, smoking status, history of treatment, and BMI	Multivariate logistic analysis. Lower level of education and low household incomes were significantly associated with chronic obstructive diseases	Large population-base sample, and high overall response rate	Education and income levels are risk factors for chronic obstructive diseases	More replicative studies for conclusive evidence	TB control measure to incorporate educated and employment opportunities

Parwal, C. Kaushik, A., Makkah, N., Banavaliker, J. N., Hanif, M, et al.(2013). Incidence and risk factors for extremely drug-resistant tuberculosis in Delhi Region. e55299. *PloS ONE 8.2.* Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed	Socio-ecological model	To determine demographic and clinical risk factors associated with XDR-TB in Delhi	611 MDR-TB suspects enrolled in four tertiary hospitals in Delhi region, India	Retrospective study involving 2007 and 201 data	Multivariate logistic regression analysis. Family history, socio-economic status, co-infection an drug abuse were significantly associated with occurrence of XDR-TB (resistant to second-line drugs-Amikacin, Capreomycin, Ofloxacin, and Ethionamide)	More replicative studies for conclusive evidence	Family history of Tb, socio-economic status, co-infection, and drug abuse are predictors of XDR-TB development	More studies on XDR-RB development under differed socio-economic settings	Early detection of both TB and XDR-TB necessary to break the chain of XDR-Tb and TB transmission

Ferre, A., Fuhrman, C., Zureik, M., Chonaid, C., Vergnenengre, A, et al. (2012). Chronic bronchitis in the general population: influence of age, gender, and socio-economic conditions. *Respiratory Medicine,* 106(3): 467-47.1. Retrieved from http://ehist.ebscohost.com.ezp.waldenulibrary.org/ed	Not indicated	To determine the burden of chronic bronchitis, the magnitude of under-diagnosis and the influence of age, gender, and socio-economic conditions on chronic bronchitis	9050 French participants aged 45 or more years	Cross-sectional study	Multivariate analysis; male gender, active smoking, lower income, and occupational category were significantly associated with CB	The sample was sufficiently large	Manual workers, self-employed, men, and low SES were predictors of CBD. There was also under-diagnosis of the disease	More studies to understand the phenomena of under-diagnosis of the disease in high SES categories.	Socio-economic circumstances of the population to guide formulation of prevention programs for CBDs including TB

ıbubakar, I., Zignol, M., F Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/ehalzon, D, et al. (2013) Drug-resistant tuberculosis: time for visionary political leadership. *The Lancet Infectious Diseases*, Early Online publication http://www.sciencedirect.com/science/article/pii/S1473309913700306	Socio-ecological model	To study the incidence and prevalence of MDR-TB worldwide	Incidence and prevalence of MDR across WHO member countries	Analysis of the data on MDR-TB reported by WHO member countries	Multivariate analyses	A large international representative data set	Incidence and prevalence of MDR-TB and XDR-TB on the increase worldwide	Research on new drugs effective against TB	Effective political and public health leadership critical in the fight against TB in terms of enhanced financial resources for TB prevention programs

l Sahly, H.M., Teeter, C.D., Pawlak, R.R., Musser, J. M., & Graviss, E.A. (2006). Drug-resistant tuberculosis: a disease of target populations in Houston, Texas. *J infection,* 53(1): 5-11. Retrieved from http://www.sciencedirect.com/science/article/pii/S0163445305003002	Socio-ecological model	To analyze the traditional and molecular epidemiology of TB drug-resistant TB in Houston, Harris County, Texas in the setting of decreasing disease incidence	193 patients with MDR-TB and 1977 patients with drug-susceptible TB identified from population base surveillance, 1995-2001	Case-control study	Multivariate logistic regression. HIV, history of past TB, being foreign-born, and younger age were predictors of MDR-TB	No specific focus on predictors of MDR-TB among foreign-residents	There is a steady low-level incidence of MDR-TB in Houston which disproportionately affects specific subpopulations	There is need for investigation on specific predictors of MDR-TB among foreign-born residents in Houston	TB prevention and control programs in the city should focus on the foreign-born and minority community populations

Bang, K.M., Weissman, D. N., Wood, J. M., & Attfield, M. D. (2005). Tuberculosis mortality by industry in the United States, 1990-1999. *Int J tuberculosis Lung Dis,* 9(4): 437-342. Retrieved from http://wwww.ncbi.nlm.nih.gov/pubmed/15830750.	Using national Center for Health Statistics multiple-cause-of death data	To identify occupations and industries with elevated respires tuberculosis in the US for the period 1990-1999	Restricted to certain states for which information on decedents industry and occupation information was available, and for U.S.persons of age 15 and above	Retrospective secondary data analysis of National Center for health Statistic	Computation of Proportional mortality ratios, adjusted for sex. Age, and race. Based on U.S. Census occupation and industry classification. The study found that industries and occupations involving potential	This was a large national database	Potential for exposure and disease development still exist, among certain worker groups.	Need for further investigation compliance for occupational safety and health standards.	The findings will guide occupationally targeted TB prevention programs.

Hansel, N. N., Merriman, B., Haponik, E. F., & Dette, G. (2004). Hospitalization for tuberculosis in the United States in 2000: Predictors of in-hospital mortality. *Chest*, 126(4): 1079-1086. Retrieved from http://wwww.ncbi.nlm.nih.gov/pubmed/15486367 .	Using 2000 Nationwide Inpatient Sample data analysis	To describe the characteristics of hospitalized patients with TB and identify patient characteristics associated with in-hospital mortality	2000 U.S. in-hospital admission sample	Cross-sectional study	Mortality was the outcome measure. Logistic regression analysis including age, race, insurance status, income, Deyo-adapted Charlson Co morbidity Index (DCI), HIV status, hospital admission source, and hospital	Large national representative sample.	Patients with TB who died during hospitalization were older (mean age, 65.1 vs 49.4 respectively ; $p \leq 0.001$), had greater co morbidity illness, require longer hospitalization, and accumulated higher charges ($79,585 vs $ 31, 610).	More research on predictors of in-hospital TB mortality among foreign-born persons.	More rigorous clinical and prevention strategies should specially target older TB patients and those with co-morbidity .

Mitruka, K., Winston, C. A., & Navin, T.R.(2012). Predictors of failure in timely tuberculosis treatment completion, United States. *Int J Tuberculosis Lung Dis*., 16(8): 1075-1082.doi: 10.5588/ijtld.11.0814. .	U.S. Tuberculosis Surveillance System	To examine failures in timely TB treatment completion to identify interventions towards achieving the national goal of ≥ 93% treatment completion in ≤ 12 months among patients eligible for 6-9 months regimens.	1993-2006 treated TB patients reported on the National Tuberculosis Surveillance System (NTSS).	1993-2006 trends analysis on TB timely treatment completion using Poisson regression to assess predictors for timely completion..	Timely treatment completion improved from 64% in 1993 to 84% in 2006 with similar trends among foreign-born and U.S.-born persons. Subpopulations at higher risk for failure in timely completion were foreign-born with co-	Large national representative sample; limitations was due to misclassification of disease entry errors	Particular attention to timely completion is needed for subpopulations requiring medical expertise in TB management and those at high risk for treatment for non-adherence, especially if foreign-born.	More research on predictors for non-adherence for timely completion of treatment completion among foreign-born persons.	Understanding and addressing causes of delayed completion and improving documentation of treatment completion among all cases will be crucial to achieving the U.S. goal.

Woodruff, R.S., Winston, C.A., & Miramonte, R. (2013). Predicting U.S. tuberculosis case counts through 2020. PLOs one, 8(6): 1-7. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh	NTSS data analysis.	To predict through 2020 the number of U.S. TB cases among U.S.- and foreign-born persons from counties of birth.	NTSS reported TB cases between 2000 and 2010.	Retrospect ive studys tudy	The NTSS data from 2000-2010 log transformed and linear regression performed to calculate annual case counts and 95% prediction interval	National representative sample	Decreases were predicted between 2010 observed and 2020 predicted counts for total TB cases (11,182 to 8,117[95% prediction interval, 7, 262-9,073]) as well as TB cases among foreign-born persons, but TB disparity between foreign-born and	Understanding influence of TB prevalence among foreign-born persons will assist TB control programs in concentrating resources where they can have greatest impact on preventing transmiss

Seaworth, B., Field, K., Flood, J. Saliba, J, J., Mase, S., Cronin, K., & Shah, N. (2013). Interruptions in supplies of second-line ant tuberculosis drugs-United States, 2005-2012. *MMWR,* 62(2): 23-26. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh	National Survey of public health departments on TB drugs situation	To investigate growing issue of TB drug shortages.	33 Public Health Departments	Survey on TB supply situation.	79% of the responding departments(26), representing 75% of the U.S. TB burden, reporter MDR-TB during 2005-2010.Of these 21 (81%) faces difficulties with SLD procurement,, citing nationwide	Large national sample size representing the main TB areas in the United States.	Adverse TB treatment outcomes or other problems related to difficulties with SLD procurement were reported by 19 (90%) of 21 jurisdictions, with treatment delay (58%), treatment lapse, or interruptions (36%), or use of inadequate regimens (32%) most	Research for more effective SLD delivery system, research into development of new SLDs, and research into better understanding of TB prevention strategies.	Novel strategies of improving continuity of SLD supplies including sharing of drugs in short supply among states and local Tb programs, centralized drug stockpiling, ability to obtain drugs from foreign

Rick, P. M., Cain, K., Oeltmann, J.E., Kammerer, J. S., & Moonan, P. K. (2011). Estimating the burden of tuberculosis among foreign-born persons acquired prior to entering the United States, 2005-*2009.PLoS ONE, 6(11): 1-6.* Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh	NTSS data analysis.	To estimate the proportion of foreign-born persons with TB Due to reactivation TB and describe characteristics of foreign-born persons with reactivation TB	NTSS reported reaction TB infections.	Cross-sectional study	Among foreign-born persons with TB (87.7%) were attributed to reactivation	Limitation of the study include non articulation why reaction occurred while recommended prophylaxis therapy to prevent active TB disease in persons with LTBI are in place	Reactive TB the leading cause of TB among foreign-born persons	There is need to evaluate this finding undue different settings, and determine why reactivation is a problem when there is an active prophylaxis therapy in place and the screening of immigrants into	TB prevention strategies to encompass overseas TB prevention, particularly among TB endemic regions.

Warkentin, J., Flood, J., True, L., Kanouse, J., Shah, N., Mase, S., Cronin, A., & Chorba, T. (2013). Impact of a shortage of first-line ant tuberculosis medication of tuberculosis control …United States, 2012-2013. *MMWR,* 62(20): 398-400. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh	National Survey of the Departments of Health on the Supply Situation of the First-line TB treatment drugs.	To assess the extent of shortages of the first-line TB treatment regimen drugs and its impact on TB control program	Public Departments of Health.	Survey	79% of the respondin g departmen ts reporter difficultie s with procureme nt INH within the last month, with15% reporting they no longer had INH and 41% reporting that they no longer have supply within I month of	Nationw ide survey of TB control program s.	The INH shortage was interfering with patient care and could contribute to TB transmissio n in the United States.	There is need to investiga te how this shortage influence TB prevalen ce among foreign-born persons in the United States	Neighbor ing TB control jurisdicti ons should encourag e sharing of available supplies. The CDC to be empower ed to deal with coordinat ion of first-line TB drug supplies rather than the FDA.

Perri, B.R., Proops, D., Moonan, P., Munsiff, C., & Ahuja, S.D. (2011). *Mycobacterium tuberculosis* cluster with developing drug resistance New York, New York, USA. . Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh	A survey of TB patients receiving treatment in TB clinic within the State of New York between 2004 and 2006.	To establish links between TB patients, and form of transmission	TB patients receiving treatment for TB within New York State between 2004 and 2006	Survey of state TB patients receiving treatment within the State of New York in 2004-2006 involving cluster investigation to establish association between patients for epidemiological links	Using Pearson X2/or Fisher exact test(for categorical data) and Mann-Whitney test (for continuous data) the researchers determined that in 2004 the tuberculosis strain in New York was drug susceptible, but isoniazid resistance	The sample was small	Patient links were associated with drug use among patient infected with isoniazid-resistant *M. tuberculosis*.	More investigation determine if isoniazid-resistant TB among foreign-born persons is influenced by drug abuse	Understanding and preventing TB transmission among hard-to-reach populations require considerable resources.

Goswami, N., Gadkowski, L. B., Piedrahita, C., Bissette, D., Ahearn, M. A., Blain.,…Stout, J. E. (2012). Predictors of latent tuberculosis treatment initiation and completion at a U.S. public health clinic: A prospective cohort study. *BMC Public Health,* 12(1): 468-475. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh	Patient interviews	To determine predictors of LTBI treatment initiation	A local public health clinic in North Carolina, involving patient of more than 17 years of age	Self-administered questionnaires, clinic intake forms and U.S. Census data	Relative risk analyses indicated that predictor of LTBI initiation include non-employment, as a reason for screening, close contact to an infectious TB case, regular primary care, and history of incarceration	The objective of the study was good in terms of seeking to understand the most effective strategies of preventing and controlling TB in the US, but there is need to focus study specifically on	Persons in the high risk category for progression/ transmission of TB disease had higher likelihood of treatment ignition.	Further research on predictors of LTBI initiation among foreign-born populations is require.	Support and access to regular primary care may lead to increased LTBI therapy adherence in high-risk populations

Deresinski, S. (2012). TB in the US—Things continue to improve, but there is a long road a head. *Infectious Disease Alert,* 31(8): 85-87. Retrieved from http://www.ebscohost.com.ezp.waldenulibrary.org/eh	NTSS	To investigate TB trends among races/ethnic groups in the United States.	NTSS case reports to the CDC in 2010 and 2011.	NTSS data descriptive statistics analyses	Five counties of origin accounted for 54.1% of the national TB cases among foreign-born: Mexico, the Philippines, Vietnam, India, and China.	The study did not address specific predictors of TB prevalence among foreign-born populations	Four states(California, Florida, New York, and Texas) accounted for more than 50% of all national TB cases, and MDR-TB is increasing among foreign-born populations who accounted for 82.6% of the total MDR-TB cases in 2010, and 100% of all XDR-TB	More research effort to understand the foreign-born populations suffer high TB and MDR-TB in a setting of declining TB prevalence in the United States.	More effort on TB prevention should focus the foreign-born populations

Appendix C

CITY OF HOUSTON
Department of Health and Human Services

Annise D. Parker
Mayor

Stephen L. Williams, M.Ed., MPA
Director
Houston Department of Health
and Human Services
8000 N. Stadium Drive
Houston, Texas 77054-1823

T. 832-393-5169
F. 832-393-5259
www.houstontx.gov
www.houstonhealth.org

December 1, 2014

James Isaboke
1710 Old Alvin Rd., Apt. # 10206
Pearland, TX 77581

Dear Mr. Isaboke:

Your request to conduct the study entitled "*Co-morbidity, Type of Housing and Prevalence of Tuberculosis and Multidrug Resistant TB Complications Among Foreign Born Persons in Houston Texas*" within the Tuberculosis Control Bureau of the Houston Department of Health and Human Services has been reviewed (by expedited review) and approved from December 1, 2014 to May 29, 2015. If the study needs to continue beyond the ending date, you must submit an extension request and a progress summary.

Mr. Richard Stancil, the Tuberculosis Control Bureau Chief, will facilitate access to de-identified data of tuberculosis patients meeting the study criteria. The study and all processes will be subject to Houston Department of Health and Human Services policies and procedures and the operational capacity of the Tuberculosis Control Bureau.

Please note that according to the policy guidelines, the Houston Department of Health and Human Services must receive a copy of all reports and/or publications resulting from this study.

Sincerely,
Luther Harrell MD

Luther Harrell, M.D.
Chief Physician, Community Health Services
Chair, Investigative Review Committee
Houston Department of Health and Human Services
8000 N. Stadium Drive
Houston, TX 77054
832-393-4385
luther.harrell@houstontx.gov

xc: Richard Stancil, Bureau Chief, Tuberculosis Control