2016

The Impact of Social Determinants on Tuberculosis Incidence Trends in New Jersey

Thomas Larry Brown
Walden University

Walden University

College of Health Sciences

This is to certify that the doctoral dissertation by

Thomas Larry Brown

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. Aaron Mendelsohn, Committee Chairperson, Public Health Faculty
Dr. Vasileios Margaritis, Committee Member, Public Health Faculty
Dr. Joseph Robare, University Reviewer, Public Health Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2016

Abstract

The Impact of Social Determinants on Tuberculosis Incidence Trends in New Jersey

by

Thomas Larry Brown

MS, American University, 1995

MS, Howard University, 1980

BS, Howard University, 1976

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

December 2015

Abstract

Social determinants have impacted disease states. The purpose of this study was to determine the influence of social determinants on the incidence of tuberculosis over a 20-year period for the state of New Jersey to determine interventions that can be developed for the state. The epidemiological triad (host-agent-environment) served as the theoretical foundation for this study. A quantitative series of cross sectional analyses were performed using secondary data from a New Jersey Department of Health database on population tuberculosis incidence for the state. Categorical data analyses were used to describe the data. According to study results, certain social determinants; such as gender, substance abuse, residence, and place of birth; and the age of the patient had an impact on tuberculosis incidence trend at the state level. The social change implications for this project could be that identifying the factors that impact tuberculosis incidence may reduce and lead to more targeted interventions, which in turn, would help to reduce the different kind of burdens; such as financial, social, and emotional; associated with this disease on the community where it is occurring.

The Impact of Social Determinants on Tuberculosis Incidence Trends in New Jersey

by

Thomas Larry Brown

MS, American University, 1995

MS, Howard University, 1980

BS, Howard University, 1976

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

December 2015

Dedication

I dedicate this research study to my parents, Mrs. Julia H. Brown and the late Charles B. Brown, Sr.; to my brother, my sister, and my In-Laws; and to my family, friends, and acquaintances who are rooting for me literally, figuratively, and spiritually. I also dedicate this research study to my Creator and God, and His Son Jesus who are my Rock and Shield, my high tower in the time of trouble, and my guide throughout this challenge.

Acknowledgments

I wish to thank first my dissertation committee who to me wanted me to be "second to none", especially Drs. Aaron Mendelsohn my chairperson and Vasileios Margaritis, along with Dr. Joseph Robare, my University Research Reviewer. Secondly, I like to thank the Writing Center's Staff for helping me to clear some bumps in the road. Next, I want to thank my editors, Mrs. Doris Foggie and Mrs. Sandra Haywood-Jones. Lastly, I give thanks to family, friends, and God for being with me.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Consistent with other infectious diseases, understanding tuberculosis and its epidemiology requires an appreciation of the host, environment, and agent, in this case, *Mycobacterium tuberculosis* (Comas & Gagneux, 2009).

In this study, I focused on the dynamics between the host and the environment, which was assessed through observational research techniques. In Chapter 1, I present rationale for this study, background, problem statement, purpose, the nature of the study, the research questions and hypotheses, theoretical base, definition of terms, assumptions, limitations, delimitations, and the significance of the study. I close the chapter with the summary.

Background of the Study

The purpose of this study was to examine the epidemiological characteristics of tuberculosis incidence with regards to social determinants at the state community level. In the literature, the epidemiological characteristics of tuberculosis incidence have been shown on multiple community levels (Barr, Diez-Roux, Knirsch, & Pablos-Mendez, 2001; Centers for Disease Control and Prevention, 2011; Dye, Lonnroth, Jaramillo, Williams, & Raviglione, 2009). Some of these community levels have been reviewed in more detail than others (Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007). Social determinants have been shown to have an association with tuberculosis in the literature (Lonnroth, Jaramillo, Williams, Dye, & Raviglione, 2009). The kind of epidemiological association between tuberculosis and its social determinants with time is limited at some community levels with regards to the literature (Bloss et al., 2011; Dye et al., 2009; Hargreaves et al., 2011; Oren et al., 2011). One of these community levels that is limited is the state level.

While tuberculosis epidemiology was evaluated for the United States as a whole, there are limited data on disease trends at the state level. Understanding how the disease patterns change for smaller units rather than the nationwide level are useful, especially given the varying disease rates across states. To illustrate this fact, New Jersey has a tuberculosis incidence rate of 4.7 cases per 100,000 people per year, but the adjacent states of Delaware and Pennsylvania have rates less than 3.6 cases (Centers for Disease Control and Prevention, 2011). An infected person can crossed some states' borders by land vehicle travel in about 2 hours (Centers for Disease Control and Prevention, 2008).

Researchers who have examined tuberculosis have demonstrated that several key factors that are involved with the spread of disease, including risk and social (e.g., living with someone with the disease), or health (e.g., immunocompromised state; Frieden, Sterling, Munsiff, Watt, & Dye, 2003). Risk, social, and health factors are known to be determinants in the continued spread of tuberculosis (Frieden et al., 2003). These factors are discussed in more detail in the next section. What is unclear is which determinant(s) are the primary factor influencing the spread of tuberculosis.

Problem Statement

Tuberculosis is still a significance health situation. Tuberculosis is a public health problem with 9.4 million cases worldwide and resulting in 1.7 million deaths per year (Dye et al., 2009; Lawn & Zumla, 2011). In the United States, the morbidity for tuberculosis is about 3.6 cases per 100,000 populations and the mortality is approximately 0.2 deaths per 100,000 persons (Centers for Disease Control and Prevention, 2011).

Health determinants and social determinants affect the presence of *Mycobacterium tuberculosis,* the bacterium that causes tuberculosis (Frieden et al., 2003). These health determinants of tuberculosis include malnutrition and incomplete/inadequate treatment of disease (Boccia et al., 2011; Shieh et al., 2006). The social determinants for tuberculosis include over-crowdedness, poor housing structures, and others (Barr et al., 2001; Lin, Ezzati, & Murray, 2008). Furthermore, the determinants for disease may change over time in geographic locations (e.g., New Jersey state; Dye et al., 2009; Hargreaves et al., 2011; Myers, Westenhouse, Flood, & Riley, 2006; Restrepo et al., 2011). The changes in the determinants of a disease cause a disruption in the intervention of a disease. What the disruption is can be difficult to determine. Finding a disruption due to the changes in determinants was one of the objectives of this study.

States with larger populations have witnessed higher rates of incident tuberculosis, like New Jersey. New Jersey is next to two states with lower tuberculosis incidence (Centers for Disease Control and Prevention, 2011). It is important to examine some of the demographics, besides size of population, to understanding why some states have high tuberculosis incidence (Davidow, Mangura, Napolitano, & Reichman, 2003). The situations within New Jersey for having high number of tuberculosis cases become the question for New Jersey.

Nature of the Study

In this quantitative study, I examined the incidence of tuberculosis between the years of 1993 and 2012 in the state of New Jersey. Secondary data were obtained from the Department of Health database on population incidence of tuberculosis for the state of New Jersey. The independent variables were age, gender, residence, place of birth, and substance abuse. The dependent variable was the number of new cases of tuberculosis. The association between the independent variables and the dependent variable was analyzed by categorical data analysis, including chi-square analyses and Poisson regression.

Research Questions and Hypotheses

These research questions and hypotheses for this study are listed below:

1. What is the independent effect of gender on tuberculosis incidence trend in the state of New Jersey from 1993 to 2012?

$H_0$1: There is no association between gender and the tuberculosis incidence trend.

$H_1$1: There is an association between gender and the tuberculosis incidence trend.

2. What is the independent effect of place of birth on the tuberculosis incidence trend in the state of New Jersey from 1993 to 2012?

$H_0$2: There is no association between place of birth and the tuberculosis incidence trend.

$H_1$2: There is an association between place of birth and the tuberculosis incidence trend.

3. What is the independent effect of substance abuse on the tuberculosis incidence trend in the state of New Jersey from 1993 to 2012?

$H_0$3: There is no association between substance abuse and the tuberculosis incidence trend.

$H_1$3: There is an association between substance abuse and the tuberculosis incidence trend.

4. What is the independent effect of residence on the tuberculosis incidence trend in the state of New Jersey from 1993 to 2012?

$H_0$4: There is no association between residence and the tuberculosis incidence trend.

$H_1$4: There is an association between residence and the tuberculosis incidence trend.

Theoretical Base

The epidemiological triad is the theoretical base for studying communicable diseases (Friis & Sellers, 2004). The epidemiological triad is composed of the host, the environment, and the pathogen aspects (Friis & Sellers, 2004). The interactions between these three aspects are the key determinants for understanding the epidemiology, namely the frequency of communicable diseases like tuberculosis (Comas & Gagneux, 2009).

Definitions

The definitions of terms that were used in this study are stated here. The definitions of these terms are used throughout this study, and no other definitions were accepted.

Place of birth: The geographic location where a person was born. For the purpose of this study, place of birth was defined as U.S.-born or foreign-born, recognizing that the geographic location is related to factors that have been shown to be related to tuberculosis incidence (Thompson, Manderson, Woelz-Stirling, Cahill, & Kelaher, 2002).

Residence: The jurisdiction that a person resides in, which is differentiated by the median price of housing and geographic location in this study. Residence points to the external environment of the host and the presence of tuberculosis in that external environment. Residence covers the habitat and the description in which the host lives (Kim et al., 2003; Wylie, Shah, & Jolly, 2007).

Substance abuse: A binary variable (yes/no) and includes the use of alcohol and other drugs (illicit drugs; Boccia et al., 2011; Craig et al., 2007).

Trend or trends: Patterns over time. For the purposes of this investigation, a series of cross sectional studies is used to describe the trend or patterns of tuberculosis incidence over time (Chan et al., 2011).

Assumptions

In this study, the analyses were based upon secondary data, and I was not involved in the data collection processes. Thus, it was assumed that the data are valid. Furthermore, the manner of collection and definitions for variables of interest (e.g., substance abuse) was assumed to be consistent over time (e.g., substance abuser in 1993 would have been classified as an abuser in 2010). Finally, it was assumed that the database captured all new tuberculosis cases-at the very least that the rate of new cases capture was consistent over the duration of the study time period.

Limitations

The major limitation for this study was that I used secondary data. Thus, the research was dependent upon the available data and the manner in which the data were collected and recorded. Other variables of interest (e.g., body-mass index) were not available and were not be used in the analysis.

Scope and Delimitations

This study was based upon the data included in the database of the New Jersey Department of Health. The database includes data on all new (including reactivation) tuberculosis cases reported to the state. This research was limited to the noninstitutionalized population.

Significance of the Study

The purpose of this study was to analyze social determinants in relation to the tuberculosis incidence on the state level over a period of 20 years. In the analysis of the social determinants, I observed whether there were trends in the occurrence of the selected social determinants on the state level. The social determinants have been indicted to have an influence on the tuberculosis incidence. The influence of the social determinants can be a factor that can increase or decrease the transmission of tuberculosis from person to person. Finding the type of trends that influence tuberculosis incidence can aid in controlling the transmission of tuberculosis. The type of trends can give public health workers an understanding of how tuberculosis transmission has been maintained in a particular social environment.

The environment, whether physical or social, is a factor in the incidence of tuberculosis. The characteristics of the physical environment can be examined in a physical science laboratory, such as a microbiology laboratory or a biochemistry laboratory. The characteristics of the social environment can be observed in social environmental settings. The social environmental settings can be on many levels from the individual level to the global level. Each level has its own form and type of social interaction. What can occur on one level might or might not occur on the other levels. Some social environment characteristics have been found on a global or regional level or on an individual or local community level, but not on a state community level. The characteristics of the social environment on a global community level are not the same characteristics on the local community level. New Jersey is a state with a high tuberculosis incidence. In addition, New Jersey has a more diverse population in ethnicity, social environment, and socioeconomic status than most states, making New Jersey an optimal region for assessing the relationship between health and social factors and tuberculosis (United States Census Bureau, 2009).

The characteristics of the host reflect some of the characteristics of the environment. In some cases the characteristics of the host are a reaction to the characteristics of the environment; for instance, in a cold environment, the host might sneeze. The characteristics of the host range from the individual level to the population level. The reactions or interactions of the characteristics of the host with the characteristics of the environment are called demographics. The demographics are interactions between the environment and the host on each level of the environment and of the host. The interactions show which determinants are influencing the situation. An analysis of the social determinants of tuberculosis incidence is not available at the state level. Therefore, the results of this study may include reducing the social burden associated with the transmission and infection of tuberculosis and enhancing the development of interventions against tuberculosis.

Summary and Transition

This chapter started with sections on the trends in the tuberculosis incidence. In this chapter, I covered the background of study, the problem statement, and the purpose of the study. I presented the assumptions, limitations, and delimitations of the study to ensure the validity of the study. The theoretical base, nature of the study, significance of study, and definitions along with the research questions and hypotheses set the direction of the study. In Chapter 2, I will present the literature review.

Chapter 2: Literature Review

Overview

Studying tuberculosis is intertwined in the trend analysis of tuberculosis incidences. The trends of tuberculosis infection need to be examined in order to find an appropriate approach to characterize the trends, allowing health providers and others have the opportunity to intervene and control the disease. The purpose of this study was to quantitatively analyze the impact of social determinants on tuberculosis incidence trends in the state of New Jersey. To determine the research has been done on the tuberculosis incidence trends, I searched the literature to provide a foundation for the literature review.

Social and health determinants affect the transmission of tuberculosis (Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007). The rate of transmission for different determinants can vary as the focus within the different community levels. The community levels for the transmission of tuberculosis and the determinants of tuberculosis transmission are established at the global, national, and local community levels, but not at the state community level.

I start the literature review with the presentation of the library databases I used to find articles on tuberculosis. To better understand tuberculosis, I present the epidemiology of tuberculosis. Also, I discuss the pathophysiology of the disease. In this study, I describe the theoretical model necessary to complete my study of tuberculosis. I then discuss the applications of the theory and variables. In a literature review on methodology, I describe how data were collected and analyzed. I provide a summary to close out this literature review.

Literature Search Strategy

To search for literature on tuberculosis, I selected and searched the PUBMED, CINAHL, and MEDLINE databases. I focused on periodicals that were dated from 2000 to 2011. My search criterion started with the keywords *tuberculosis* or *Mycobacterium tuberculosis* in peer-reviewed journals, and my search result yielded over 190,000 hits. To narrow the number of hits, I added keywords to each round of searches. Some of the keywords that I added were *Mycobacterium tuberculosis*, *pathophysiology*, and *social factors*. I changed the search category for some of the keywords from *all categories* to *in text* or *in the title* in order to narrow the search results. The literature search results produced articles that covered information on the pathogen, epidemiology, pathophysiology, and social determinants of tuberculosis. Additionally, I conducted literature searches for background information on social determinants and social ecology as well as statistical procedures.

Epidemiology of Tuberculosis

Regardless of the level of community, tuberculosis produces morbidity and mortality. On the global level, tuberculosis is a leading source of mortality and morbidity (Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007). Tuberculosis influences the working of public health departments of each state and the District of Columbia along with the territories of the United States. For New Jersey, the various sources of tuberculosis incidence are factors for the presence of tuberculosis in the state

(Centers for Disease Control and Prevention, 2006, 2011; Dye et al, 2009). The community is affected by tuberculosis from the local level up to the global level.

Worldwide tuberculosis has influence. Globally *Mycobacterium tuberculosis* infection has a morbidity rate of about 9.4 million cases as of 2009 (Lawn & Zumla, 2011). The mortality rate from tuberculosis is about 1.7 million deaths per year (Dye et al., 2009; Lawn & Zumla, 2011). Some of the health and social determinants are malnutrition, overcrowdedness, and poor housing structures (Bloss et al., 2011; Craig et al., 2007; Hargreaves et al., 2011; Sharpe, Harrison, & Dean, 2010). In addition, reactivation of latent infections is a factor in the morbidity of tuberculosis (Ahmad, 2011; Shieh et al., 2006). The geographical locations where the morbidity rate is high for tuberculosis are in Africa and Asia (Dye et al., 2009; Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007). Tuberculosis infection occurs worldwide, but at the national level, tuberculosis incidence can be seen differently.

In the United States, the tuberculosis morbidity is declining, and tuberculosis mortality is an infrequent event. The morbidity rate of tuberculosis in the United States is 3.6 cases per 100,000 populations, and the mortality rate is 0.2 deaths per 100,000 populations for 2009 (Centers for Disease Control and Prevention, 2011). Among the states, the range for incidence rates of tuberculosis is 9.1 per 100,000 populations for Hawaii to 0.4 per 100,000 populations for Wyoming (Centers for Disease Control and Prevention, 2011). Foreign-born persons have a higher incidence rate of tuberculosis than U.S.-born persons (Centers for Disease Control and Prevention, 2006, 2011; Oren et al., 2011). According to the ethnic distribution of tuberculosis cases, Asians have the highest incidence rate, with Hispanics and Blacks having the next highest incidence rate, and with Whites having the lowest incidence rate of tuberculosis (Centers for Disease Control and Prevention, 2011). The national tuberculosis composition level can be different than the state level.

For New Jersey, the morbidity rate of tuberculosis is decreasing. New Jersey ranks ninth among the states with the highest rate of tuberculosis cases at 4.7 per 100,000 populations for 2009 (Centers for Disease Control and Prevention, 2010). The ethnic distribution of tuberculosis cases in New Jersey is 33.4% Asians, 32.3% Hispanics, 21.5% Blacks, and 12.4% Whites for 2008 (New Jersey of Department of Health, 2009). Most of the tuberculosis cases are foreign-born patients. The jurisdictions of New Jersey with the highest cases of tuberculosis are Bergen County, Essex County, Hudson County, Middlesex County, Passaic County, and Union County (New Jersey of Department Health, 2009). In regards to gender, males have more cases of tuberculosis than females (New Jersey of Department Health, 2009). The age distribution for New Jersey is skewed to 35 years and older of (New Jersey of Department Health, 2009). Pathophysiology is used to show what tuberculosis is doing on the individual level.

Pathophysiology of Tuberculosis Infection

Mycobacterium tuberculosis is transmitted from person to person by way of airborne droplets. The airborne droplets can be suspended for hours in the air. The airborne droplets that carry the mycobacteria are generated by sneezing, coughing, talking, and singing (Frieden et al., 2003). Infection occurs with the inhalation of the mycobacteria airborne droplets. The infection site for *Mycobacterium tuberculosis* is the alveolar of the lungs. The incubation period for tuberculosis is from 2 to 10 weeks (Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007). During or after the incubation period, the tuberculosis infection can become either an active infection or latent infection. Whether the infection being active or latent is dependent on certain conditions that can occur on the cellular level (Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007). The steps of a tuberculosis infection are seen on the cellular level.

On the cellular level, the *Mycobacterium tuberculosis* is phagocytized by macrophages in the alveolar. In the macrophages, *Mycobacterium tuberculosis* cells continue to multiply (Frieden et al., 2003; Korbel, Schneider, & Schaible, 2008). The infected macrophages with *Mycobacterium tuberculosis* release antigens of *Mycobacterium tuberculosis* (Frieden et al., 2003; Korbel, Schneider, & Schaible, 2008). The antigens cause dendrite cells and T-lymphocytes to react. The reactions of the dendrite cells and the T-lymphocytes cause the production and the release of cytokines along the formation of granulomas (Frieden et al., 2003; Korbel, Schneider, & Schaible, 2008). Granulomas are the encasing of infected macrophages and dendritic cells that are surrounded by T-lymphocytes (Frieden et al., 2003; Korbel, Schneider, & Schaible, 2008). In the granulomas *Mycobacterium tuberculosis* can either continue to replicate or go into a latent state. If *Mycobacterium tuberculosis* continues to replicate and break out of the granulomas, then the cellular response restarts and an active state can begin (Frieden et al., 2003; Korbel, Schneider, & Schaible, 2008). On the molecular level, *Mycobacterium tuberculosis* causes the activation of the cytokines.

On the molecular level of *Mycobacterium tuberculosis* infection, the infection is associated with the movement of cytokines. The production of cytokines is based on the response to the presence of antigens or other cytokines (Frieden et al., 2003; Korbel et al., 2008; Nicod, 2006). The dendritic cells in reaction to the mycobacteria antigens produce tumor necrosis factor (Frieden et al., 2003; Korbel et al., 2008; Nicod, 2006). Tumor necrosis factor stimulates T-lymphocytes to generate interferon, interleukin, and more tumor necrosis factor (Frieden et al., 2003; Korbel et al., 2008; Nicod, 2006). Interferon activates other T-lymphocytes to kill the infected macrophages. Interleukin causes the macrophages to go into apoptosis. Tumor necrosis factor, in addition to stimulating T-lymphocytes, along with interferon causes the upregulation of oxygen radicals and nitric oxide (Frieden et al., 2003; Korbel et al., 2008; Nicod, 2006). The oxygen radicals and nitric oxide are associated with inhibiting the growth of *Mycobacterium tuberculosis* (Frieden et al., 2003; Korbel et al., 2008; Nicod, 2006). The molecular level of *Mycobacterium tuberculosis* infection is a part of diagnosing of tuberculosis in certain situations.

Diagnosis of Tuberculosis

Tuberculosis detection is a geographic location phenomenon (Frieden et al., 2003). The common symptoms of tuberculosis are night sweats, fever, weight loss, shortness of breath, persistent coughing, the coughing up of blood, and chest pain (Frieden et al., 2003; Knechel, 2009). In countries with low socioeconomic status, diagnosis is based on symptoms and sputum smear analysis (Dye et al., 2009). The diagnostic tool is the acid fast staining of sputum smear (Dye et al., 2009). In countries with higher socioeconomic status, diagnosis is based on several different laboratory tests and symptoms (Dye et al., 2009; Frieden et al., 2003). The diagnostic tools are tuberculin skin test, radiology of the thoracic area, and laboratory cultures of sputum specimen (Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007). These diagnostic tools are standard tools but newer tools are appearing.

Newer diagnostic tools for detecting tuberculosis are appearing (Lalvani, 2007; Maartens & Wilkinson, 2007; Shieh et al., 2006). These diagnostic tools are nucleic acid amplification tests, enzyme-linked immunosorbent assay, and enzyme-linked immunospot (Lalvani, 2007; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007). The nucleic acid amplification test assay is seen as a procedure that increases the concentrations of deoxyribose nucleotides or ribose nucleotides by way of polymer chain reactions (Knechel, 2009). The nucleic acid amplification test assay is used to amplify the deoxyribose nucleic acid of *Mycobacterium tuberculosis* from samples like sputum (Knechel, 2009). Enzyme-linked immunosorbent assay and enzyme-linked immunospot are similar assays (Lalvani, 2007). The procedures for both assays start off similar but the methods of detection are different.

Enzyme-linked immunosorbent assay and enzyme-linked immunospot are similar procedures. Both assays start with collecting a blood specimen from the patient. The blood specimen for each assay is processed differently. Enzyme-linked immunospot assay includes using a tube to separate the blood, but in the enzyme-linked immunosorbent assay, a 24-well plate is used for blood separation (Higuchi et al., 2009; Lalvani, 2007). Both assays use cytokines and secondary antibodies. Enzyme-linked immunosorbent assay detection is based on the measurement of optical density. Enzyme-linked immunospot assay detection is based on the appearance of a spot to determine whether a tuberculosis infection has occurred (Higuchi et al., 2009; Lalvani, 2007). These two assays are accurate for determining tuberculosis infections (Higuchi et al., 2009; Lalvani, 2007). While new techniques of diagnosis of tuberculosis are shown, the theoretical foundation is the same.

Theoretical Foundation

The theoretical model for this study was based on the epidemiological triad (Comas & Gagneux, 2009; Friis & Sellers, 2004). The epidemiological triad is composed of the host, the environment, and the pathogen (Comas & Gagneux, 2009; Friis & Sellers, 2004). By studying the interaction between these components of the epidemiological triad, researchers can understand the factors that are involved because communicable diseases do not spread randomly. The interaction between the host and the pathogen is called the host-pathogen interaction (Comas & Gagneux, 2009). The interaction between the environment and the pathogen is ecological (Comas & Gagneux, 2009). The interaction between the environment and the host is demographic (Comas & Gagneux, 2009). Each of these interactions can be a guide to laying the foundation for the epidemiological triad to be the base for some form of intervention with regards to tuberculosis (Comas & Gagneux, 2009; Friis & Sellers, 2004; Shape et al., 2010). The interactions are the foundation for the epidemiological triad with the host-pathogen interaction as a starting point for guiding through the epidemiological triad.

The host-pathogen interaction is built on the compositions of the host and the pathogen, which in this study was *Mycobacterium tuberculosis*. The compositions include the genetic makeup of the host and *Mycobacterium tuberculosis* as one component. Another component is how the host and *Mycobacterium tuberculosis* react to each other as seen in the pathophysiology section (Comas & Gagneux, 2009). The host-pathogen interaction is an involvement beyond the molecular level and cellular level (Comas & Gagneux, 2009). This involvement goes from the molecular level to the population level. This transition between levels is defined as systems biology (Comas & Gagneux, 2009; Friis & Sellers, 2004; Korbel et al., 2008). The interaction between *Mycobacterium tuberculosis* and the environment is different from the host-pathogen interaction.

The interaction between *Mycobacterium tuberculosis* and the environment is different from the other two interactions. The difference in the interactions is related to the physical environment. The physical environment influences the conditions that can prevent the existence of the airborne droplets of tuberculosis (Alani et al., 2001). Other conditions enhance the transmission of tuberculosis. Conditions such as overcrowdedness or poor ventilation are risk factors in the interaction between the environment and *Mycobacterium tuberculosis* (Comas & Gagneux, 2009; Friis & Sellers, 2004). The interaction between the environment and *Mycobacterium tuberculosis* is different from the interaction between the environment and the host because of the social and physical aspects of the environment and the host interactions.

The interaction between the environment and the host is considered to be a demographic characteristic. The demographic characteristics of the host range from the characteristics on the population level to the individual level (Comas & Gagneux, 2009). The demographic characteristics of the environment are those components that comprise the environment (Comas & Gagneux, 2009). Environmental components are either physical or social. The interaction between the environment and the host is involved each component of the environment reacting with each component of the host or vis-à-vis (Comas & Gagneux, 2009). The host and environment interaction, like the other interactions, is included in the epidemiological triad.

Literature Review on the Applications of the Epidemiological Triad

Interactions in the epidemiological triad produce different sources of data and information about tuberculosis. The interaction between the host and *Mycobacterium tuberculosis* produces biochemical and microbiological data (Ahmad, 2011; Frieden et al., 2003; Korbel et al., 2008; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007; Nicod, 2006). The environment and *Mycobacterium tuberculosis* interaction generates biochemical and microbiological data that are based on physical science (Alani et al., 2001). The interaction between the environment and the host generates some biochemical and microbiological data and some sociological data (Craig et al., 2007; Hargreaves et al., 2011; Myers et al., 2006; Sharpe et al., 2010). The biochemical and microbiological data and the sociological data are considered to be integrated (Andre et al., 2007; Wylie, Shah, & Jolly, 2007). The sociological data are the antecedent to the social determinants that are used to describe the trend of tuberculosis incidence.

The researchers doing studies on trends of tuberculosis incidence select social determinants that describe groups of people. The researchers are describing whether the social determinant is associated with one group or another (Barr et al., 2001; Bloss et al., 2011; Dye et al., 2009; Jung et al., 2010; Oren et al., 2011). Most of the researchers use archival sources to describe the association of the trends of tuberculosis incidence with the social determinants (Barr et al., 2001; Bloss et al., 2011; Craig et al., 2007; Dye et al., 2009; Jung et al., 2010; Oren et al., 2011). To analyze the association between the trend of tuberculosis incidence and the social determinants, nonparametric statistics are used (Barr et al., 2001; Bloss et al., 2011; Craig et al., 2007; Dye et al., 2009; Jung et al., 2010; Oren et al., 2011). The data collection and data analysis of the social determinants of the trend on tuberculosis incidence are varied in different methods.

The researchers' common method of analyzing tuberculosis incidence trend studies is to group the data into categories based on the social determinants. The categories of the social determinants are selected to describe the best observed social determinants (Bloss et al., 2011; Craig et al., 2007; Dye et al., 2009; Jung et al., 2010; Oren et al., 2011). The use of the best observed social determinants is to show strengths and weaknesses in the approach. Usually, the strengths of using the best observed social determinants are (a) to be able to highlight the results and (b) to show why the social determinant has had an effect. However, the weaknesses of using the best observed social determinants are (a) to not show any rate of change or (b) to use time as a factor in the occurrence of tuberculosis. The strengths and weaknesses of using the best observed social determinants of tuberculosis incidence are showing where an information gap has existed (Barr et al., 2001; Bloss et al., 2011; Craig et al., 2007; Centers for Disease Control and Prevention, 2011; Dye et al., 2009; Jung et al., 2010; Oren et al., 2011). The information gap is the rationale for selecting certain social determinants.

The information gap is the justification for using certain social determinants. The social determinants are shown to influence tuberculosis in the host, the environment, or both because communicable diseases like tuberculosis do not spread at random (Craig et al., 2007; Hargreaves et al., 2011; Myers et al., 2006; Sharpe et al., 2010). The influence that the social determinants have had is affecting the host's body in dealing with a tuberculosis infection or is making the environment to be an easier medium to spread tuberculosis (Andre et al., 2007; Hargreaves et al., 2011; Lin et al., 2007; Maher, 2003). The social determinants that are used in this study are selected because these determinants have shown to have an effect on the host by way of the environment. The social determinants are part of the interaction between the environment and the host where an information gap is existing.

Social Determinants

The social determinants for tuberculosis are based on demographics, whether an individual demographic or a collection of demographics. The usual demographics, which are being studied, for tuberculosis incidence trends are age, gender, place of birth, socioeconomic status, and substance abuse (Barr et al., 2001; Bloss et al., 2011; Boccia et al., 2011; Craig et al., 2007; Dye et al., 2009; Sharpe et al., 2010). Other studies include comorbidities, habitation, and geographic location (Bloss et al., 2011; Dye et al., 2009; Lin et al., 2007; Lin, Murray, Cohen, Colijn, & Ezzati, 2008; Schmidt, 2008). The collection of demographic variables is shown to be the social factors that influence the transmission of tuberculosis (Craig et al., 2007). The demographics mostly give a partial portrait of the social determinants that are associated with the transmission of tuberculosis from person to person.

The portrait of the social determinants describes some of the characteristics of the environment in which tuberculosis exists. The environment can exist as the physical and the social components of the demographics, such as ventilation and overcrowdedness (Comas & Gagneux, 2009; Sharpe et al., 2010). The characteristics of the environment are seen as the components that continue to affect the transmission of tuberculosis from person to person (Andre et al., 2007). The characteristics of the physical and the social components start in the framework of the interactions between the environment and the host or between the environment and the pathogen (Comas & Gagneux, 2009). The interactions between the environment and the host are the source of the social determinants that can be toward tuberculosis transmission.

The social determinants of tuberculosis are shown to change because of changes that occur in the demographics (Dye et al., 2009). Which demographics are changing is the question. The changes in the demographics have an effect on the intervention to control the spread of tuberculosis (Dye et al., 2009). The changes in the demographics that are occurring for a given period produce the rate of effectiveness for the intervention (Centers for Disease Control and Prevention, 2006, 2011; Oren et al, 2011). The studies of these changes in the demographics over a given period are focused on the national level. To find whether changes in the demographics over a given period is the same on other levels as the national level, a study has to be done.

To find what changes in the demographics over a given period for the state level, I selected the state of New Jersey for this purpose. New Jersey has some changes in demographics over the past years. The demographics that are covered in New Jersey are obesity rate, place of birth, and residence (Centers for Disease Control and Prevention, 2011; New Jersey of Department of Health, 2009). The demographics for New Jersey with regards to tuberculosis are similar to some states but are still different to other states, for example ethnic composition (Centers for Disease Control and Prevention, 2006, 2011, 2012). The changes in the demographics over a given period are a part of the question, can the same type of intervention work in each state for tuberculosis. To analyze the impact that the changes in the demographics over a given time period have on the tuberculosis cases, a listing of the demographics is needed to see the impact (New Jersey Department of Health, 2009; United States Census Bureau, 2009). The changes in the demographics with regards to tuberculosis are the prelude to the social determinants of tuberculosis.

In order to determine which social determinants have impacted the tuberculosis incidence in New Jersey over a given period, the demographics have to be analyzed. The demographics that are going to be analyzed in this study are gender, substance abuse, residence, place of birth, and tuberculosis infection status. These demographics are the ones that can be the sources to what the social determinants have been over a given period of time for the tuberculosis incidence trend.

One demographic that can be a keystone in describing the effects of a disease is gender. Gender with regards to the tuberculosis incidence is the common demographic in most studies (Craig et al., 2007; Hargreaves et al., 2011; Oren et al., 2011). Most studies are not showing any trend whether the tuberculosis incidence with regards to gender has existed, but gender indicates the social context and the emotional context of the tuberculosis incidence (Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007; Snider, 2001). Also, gender is showing certain factors, such as social roles and behavioral risk factors. For example, women have been exposed to indoor air pollution more than men (Lin et al., 2007). Another example, men have been shown to be more likely to engage in sex with other men and less likely to use drugs, while women have been shown to be users of drugs (Kim & Crittenden, 2005). The different social or risk factors are the rationale to indicate the importance for including gender as one of the demographics. However, to consider gender is viewing only part of the portrait of which the social determinants have to show about the tuberculosis incidence, but demographics, like place of birth, have become a common variable in some studies.

Place of birth as a demographic is becoming frequently associated with the tuberculosis incidence. Place of birth is used to describe where a person was originally born and not where a person resided. Place of birth is serving as a demographical source and an ecological source. The demographical source that place of birth provides is the information on a person's origin and culture environment (Thompson et al., 2002). The ecological source that place of birth provides is the information on the physical environment in which a person originates and the degree of tuberculosis presence (Dye et al., 2009; Grzywacz & Fuqua, 2000). The demographic information that place of birth provides is a possible source for some information that is needed for tuberculosis incidence, while the social and physical environmental components are pointing to another demographic, residence.

Residence is also one of the demographics that describes the environment of the host. The description that residence provide deals with the geographical location, some information on the socioeconomic status, and the degree of tuberculosis incidence for that geographical location. The geographical location shows what the physical environment is. The information on the socioeconomic status for residence comes from the median price of housing (New Jersey Association of Realtors, 2013). The information gives a partial picture of what the social component of residence is. The degree of tuberculosis incidence indicates how many tuberculosis cases can be found in that geographical location. The sum of these descriptions of residence paints the type of environment that the host exists. The host external environment is seen through place of birth and residence, but the host internal environment can be explored through substance abuse.

The demographic substance abuse is carrying similar characteristics as residence and place of birth. Substance abuse has factors that depend on environment and host. The environmental factors of substance abuse are showing the social aspect and physical component (Lin et al., 2007; Lin et al., 2008). The social aspect of substance abuse confronts social context and social network (e.g. the people that are interacting with each other). The physical component of substance abuse deals with the condition of the host's body after that substance has been introduce into the body, plus the body's reaction to the presence of tuberculosis. The physical component of substance abuse also covers the reduction of the body's immune system to react effectively to infectious agent, like tuberculosis, due to the substance that is being abused. The host factors demonstrate to being on the individual level (Lin et al., 2008). Substance abuse with regards to tuberculosis is dependent on which form of substance abuse is being viewed. Like all demographics used in this study, substance abuse is considered as an influencer of the tuberculosis incidence. Not all demographics are used in this study as variables; the exceptions have other reasons.

The excepted demographics are classified as different concepts. The main excepted demographics are age and socioeconomic status. Socioeconomic status is considered a different concept because it is omitted from the database as a possible identifier. The demographic age is considered as a demographic that is a function of time and physiology (Ahmad, 2012; Myers et al., 2006). At an early age, the patient's symptoms are different from an older person (Myers et al., 2006). At an older age, the source of the tuberculosis infection comes from either a person with an active tuberculosis infection or the reactivation of a latent tuberculosis infection because of physical deterioration due to aging (Ahmad, 2012; Shieh et al., 2006). Thus, age becomes a confounding factor. Confounding factors are shown to have an influence, like age have on the tuberculosis incidence and can be controlled.

Literature Associated with Tuberculosis Incidence

The dependent variable for this study is new tuberculosis cases or incidence of tuberculosis. The tuberculosis cases are patients who have been diagnosis with tuberculosis. The diagnosis is based on symptoms, radiographs, and laboratory analysis. The descriptions of the diagnostic processes are written in the Diagnosis of Tuberculosis section. The data and information for the tuberculosis cases are to be collected from the database belonging to the New Jersey Department of Health.

Literature Review on Methodology

The data analysis for trend studies is done by tabulation. The tabulations are seen as the grouping of cases based on demographics or other criterions (Dye et al., 2009; Oren et al., 2011; Rodwell et al., 2008). Tabulations are part of the methods to analyze trends. To analyze trends, the statistical procedures that are used are chi-square and Poisson Regression (Dye et al., 2009; Oren et al., 2011; Rodwell et al., 2008). Other forms of analysis of trends are done by graphic means (Centers for Disease Control and Prevention, 2011; Myer, Kreiswirth, Kahanov, & Martin, 2009). Trend analyses are based on nonstatistical and statistical procedures.

Trend analyses are done by statistical procedures and nonstatistical procedures. The statistical procedures for trends analyses are chi square and Poisson Regression. The nonstatistical procedures are dealing with graphs and tables. The graphs and tables are set up to show a timeline versus a frequency or number of events (Myer et al., 2009). Chi square is considered as a nonparametric technique that utilizes frequencies. Poisson Regression is seen as a statistical technique that does not follow the normal distribution and can deal with temporal trends (Gagnon, Doron-LaMarca, Bell, O'Farrell, & Taft, 2008). The difference between the statistical procedures and the non statistical procedures is that non statistical procedures are dependent on the scale of the presentation. For example, to show a trend study graphically, the scale units would have to be set at least one graphic unit above the maximum value that is found in the study and would be able to cover the period of the study. Each value would have to be placed as close to its true value on the graph. If the scaling is too small, then the difference between the values might not be seen clearly, and a false pattern might be viewed. Thus, a statistical procedure like chi square is to be used to verify the trend pattern.

Summary and Transition

In summary, the study of the impact that the social determinants have on the incidence of tuberculosis is based on the epidemiology of tuberculosis and the theoretical model. The epidemiology indicates some of the social determinants. The theoretical model becomes the vehicle to explore which social determinants have shown what influences under what circumstances. The theoretical model for this study is the epidemiological triad. The application of the epidemiological triad is a guide to what social determinants are making an impact on the incidence of tuberculosis. To study the impact, a plan or design has to be in place.

To study the impact that the social determinants is making on the tuberculosis incidence, certain research procedures have to be done. The research procedures have to deal with data collection and data analysis. The data collection and the data analysis have to generate data for the independent variables and for the dependent variable and have to be utilized by a statistical procedure to show results. The data and the results are the outcome of the research method.

Chapter 3: Research Method

Introduction

The purpose of this study was to quantitatively analyze the impact of social determinants on tuberculosis incidence trends in the state of New Jersey. Tuberculosis transmission depends on the host, the environment, and the pathogen (*Mycobacterium tuberculosis*). The dynamics between host and pathogen and between pathogen and environment have been measured in the laboratory, but the dynamics between host and environment have only been analyzed from observations and counting events. This study was a retrospective quantitative, repeated cross sectional design. The setting and sample for this study included the population of New Jersey from 1993 to 2012. The data came from the database of New Jersey Department of Health. The statistical analysis was completed by using the Statistics Package for the Social Sciences. The findings of this study were to be distributed by using peer-reviewed journals and organized presentations.

Research Design and Rationale

In this quantitative study, I used repeated cross sectional panels over a period of 20 years to examine demographics and tuberculosis incidence. Each cross sectional panel represented 1 year in the period and was used for each demographic that was being analyzed for that time period. The periods started in 1993 and ended in 2012. The demographics were gender, place of birth, residence, and substance abuse, as the independent variables. The dependent variable was new cases of tuberculosis. The confounding variable was age.

Setting and Sample

The setting for this study was the state of New Jersey. The population for this study included the noninstitutionalized persons in the New Jersey. The sampling method included using all of the tuberculosis cases that have been in the New Jersey Department of Health database since 1993. The data for this study covered past events in order for the analysis to be done. The sampling frame was the collection of patients who had been diagnosed as being new cases of tuberculosis in the database who met the criteria. The sample size came from this sampling frame.

The size, criteria, and characteristics of the sample were related to the data in the database. The estimated sample size was ~12000 persons (i.e.,~600 new tuberculosis cases/year over a 20-year period; New Jersey of Department of Health, 2009). The alpha value was set at .05 to prevent a Type I error. To deal with a Type II error, the beta value was set at .80. These values improved the probability that the results of this study were real or did have statistical power. The eligibility criteria for the study participants were having been diagnosed with tuberculosis, residing in New Jersey, and being found in the database. The characteristics of the selected sample were new cases of tuberculosis in the database. After the size, criteria, and characteristics of the sample were achieved, the instrumentation and materials were reviewed.

Instrumentation and Materials

Neither an instrument or material were used in this study. I did not use an instrument because the data were generated by counting. Counting did not require material that would be associated with instrumentation. Without the need for instrumentation and materials in place, the data arrangement and statistical analyses were the events that occurred next.

Data Arrangement and Statistical Analyses

The data arrangement and statistical analyses started with the transfer of the raw data from the storage site of the database to the site of the research storage and analysis, because the research was conducted on an established data source. The files that contained the raw data for this study were transferred into a computer file for the research analysis. The raw data in the computer file were described in a codebook from the database sources that indicated what each variable meant. The codebook included information on each variable in the database, including the variable name, the full definition of the variable, data type, size, and other information that concerned confidentiality. After the raw data transfer was completed, the raw data were organized in order to perform the data analyses.

After the transfer of the raw data to the computer file, I conducted a check to see whether the correct data were in the correct storage site and were assigned to the correct variable name. The data were analyzed by conducting univariate analysis on each variable. The univariate analysis was used to determine which variables were normally distributed and which variables were not normally distributed. After the univariate analysis was competed, each variable was studied to determine whether that variable needed to be transformed into categorical or binary data before the statistical analyses were conducted.

The statistical analyses for this study included using chi-square and Poisson statistical techniques. A chi-square was used to analyze each selected demographic from year to year. The core of the analyses included the counting of items in each category. To analyze the associations, variables were arranged as categories that were needed to conduct the analyses. For example, demographics like age were transformed from a continuous variable to a categorical variable by assigning ranges to categories. The transformation was conducted by assigning an age range of 0 to 4 years as Category 1, an age range of 5 to 14 years as Category 2, an age range of 15 to 24 years as Category 3, an age range of 25 to 44 years as Category 4, an age range of 45 to 64 years as Category 5, and an age range of 65 years and over as Category 6. The categories were used to build the contingency tables for the different demographics based on the data for each year. The contingency tables aided me in completing the analysis for each demographic. When the contingency tables were completed, the trend of that demographic was shown by the statistical analysis.

To analyze each of the research questions and their associated hypotheses, I arranged the analytic process similarly for each research questions. The research questions concerned the association between gender and tuberculosis incidence trends and place of birth and the tuberculosis incidence trends. The other research questions dealt with the effect of substance abuse on tuberculosis incidence trends and with the effect of residence on tuberculosis incidence trends. The organizing process included age and year of incidence. Age was grouped into six categories in order to control for confounding. Each age group contained counts of new tuberculosis cases for each year ranging from 1993 to 2012. For each year from 1993 to 2012, the new cases of tuberculosis were counted at the individual level and were split into categories of being or not being depending on the variable being analyzed. Those categories were related to the independent variables of the research questions. The first independent variable analyzed was gender.

The research question on the effect of gender on tuberculosis incidence trends and the associated hypotheses, was arranged using age groups, gender, and year of incidence. The age group covered the previous six age categories. Each age category was set up as a 2 by 20 array. The 2 of the 2 by 20 array was in columns and did represent female and male columns. The 20 of the 2 by 20 array was in rows and each row represented each year in the study from 1993 to 2012. The 2 by 20 array was filled by rows with each row composed of the number of females for that year and the number of males for that year. The data analyses included the Mantel-Haenszel extension of the chi-square test for trend, the Poisson Regression, and the Negative Binomial Regression (Barros & Hirakata, 2003). The Mantel-Haenszel extension of the chi-square test for trend produced a series of odds ratios (Barros & Hirakata, 2003). The odds ratios are produced as shown in Figure 1.

Exposure Level	Disease +	Disease -	Odds Ratio
1	*a*	*b*	$or_1 = 1$ (referent)
2	*c*	*d*	$or_2 = bc/ad$
...	...	...	...
R	*y*	*z*	$or_R = yb/az$

(Binary outcome, test for trend, n.d.)

Figure 1. The Mantel-Haenszel extension of the chi-square test for trend

The Poisson Regression and Negative Binomial Regression were conducted in two runs. In one run, I used the data for females and in the other run, I used the data for males. The organization and data analyses for the other research questions were similar but different from gender organization, with place of birth being next.

The research question on the independent effect of place of birth on tuberculosis incidence trends, and the associated hypotheses, was arranged using age groups, place of birth, and year of incidence. The age group covered the previous six age categories. Each age category was set up as a 2 by 20 array. The 2 of the 2 by 20 array was in the columns and represented U.S.-born and foreign-born columns. The 20 of the 2 by 20 array was in the rows and each row represented each year in the study from 1993 to 2012. The 2 by 20 array was filled by rows with each row composed of the number of U.S.-born for that year and the number of foreign-born for that year. The data analyses included the Mantel-Haenszel extension of the chi-square test for trend, the Poisson Regression, and the Negative Binomial Regression. The Mantel-Haenszel extension of the chi-square test for trend produced a series of odds ratios (Figure 1). The Poisson Regression and Negative Binomial Regression were conducted in two runs. In one run, I used the data for U.S.-born and in the other run, I used the data for foreign-born. The organization and data analyses for the next research question had differences from place of birth, which was substance abuse.

The research question on the independent effect of substance abuse on tuberculosis incidence trends and the associated hypotheses, was arranged using age groups, substance abuse, and year of incidence. The age group covered the previous six age categories. Each age category was set up as a 2 by 20 array. The 2 of the 2 by 20 array was in the columns and represented no substance abuse and substance abuse columns. The 20 of the 2 by 20 array was in the rows and each row represented each year in the study from 1993 to 2012. The 2 by 20 array was filled by rows with each row composed of the number of no substance abuse for that year and the number of substance abuse for that year. The data analyses included the Mantel-Haenszel extension of the chi-square test for trend, Poisson Regression, and the Negative Binomial Regression. The Mantel-Haenszel extension of the chi-square test for trend produced a series of odds ratios (Figure 1). The Poisson Regression and Negative Binomial Regression were conducted in two runs. The runs included the data for the number of substance abuse cases and nonabuse cases for each year. The organization and data analyses for the last research question had similarities but differences from substance abuse, which was dealing with residence.

The research question of the independent effect of residence on tuberculosis incidence trends, and the associated hypotheses, was arranged using age groups, residence, and year of incidence. Residence significance was differentiated by the median price of housing and was divided into high and low median price of housing, based on 1993 and 2012. The age group covered the previous six age categories. Each age category was set up as a 2 by 20 array. The 2 of the 2 by 20 array was in the columns and represented the high median price of housing and the low median price of housing columns. The 20 of the 2 by 20 array was in the rows and each row represented each year in the study, from 1993 to 2012. The 2 by 20 array was filled by rows with each row composed of the number of patients from high median price of housing for that year and the number of patients from low median price of housing for that year. The data analyses were the Mantel-Haenszel extension of the chi-square test for trend, the Poisson Regression, and the Negative Binomial Regression. The Mantel-Haenszel extension of the chi-square test for trend produced a series of odds ratios (Figure 1). The Poisson Regression and the Negative Binomial Regression were conducted in two runs. In one run, I used the data for patients from high median price of housing and in the other run, I used the data for patients from low median price of housing.

Threats to Validity

Threats to validity for this research were minimal. The principal method of data collecting included counting the number of patients in each group for each year of the study. The source of the data came from each case report of tuberculosis with the demographical information on each patient. With no instrument to be questioned about its validity, the threats became how the data were collected, the correct classification of the data, and whether any data had been omitted. The data came from a secondary source, the database of the Tuberculosis Control Program of the New Jersey Department of Health. Thus, the threats to validity were probably external threats, which may or may not be known, or have an effect on the data analysis. To deal with external threats, the threat has to be known so that adjustments can made. For instance, missing data for place of birth can be assigned as U.S.-born or for substance abuse can be assigned as no or not using, but for unknown external threats, the assumption was that the unknown external threat had a minimum effect or no effect.

Protection of Human Participants

The data came from an existing database; I had no direct contact with the human participants. All participant identifiers were removed from the dataset by the New Jersey Department of Health before the data were received and the data analyses began; the identifiers remained deleted throughout the dissertation process.

The beginning of the data analyses was not the final procedure for dealing with the data for this study. After the data analyses were done, the results were compiled, and the data were stored in a secure place, such as a compact disc or flask drive. After 5 years in storage, the data of this study can be destroyed or erased. The Walden University Institutional Review Board approval number was 11-07-13-0039230 and the State of New Jersey Department of Health Institutional Review Board approval number was njdohirb #0462.

Dissemination of Findings

The results of the impact of social determinants on tuberculosis incidence trends can be disseminated to three sources. The first source of interest is a peer-reviewed journal, such as the *American Journal of Public Health* or the *American Journal of*

Epidemiology. The second source of interest is a professional conference, such as *American Public Health Association Annual Meeting and Exposition* or *American College of Epidemiology Annual Meeting*. The third source of interest is a letter of information to the Commissioner of New Jersey Department of Health.

Summary and Transition

The purpose of this study was to determine the impact of social determinants on tuberculosis incidence trends in New Jersey. The research design was a repeated cross sectional design in order to cover each year that was being studied. The data for this study came from the database of the New Jersey Department of Health. The statistical techniques that were used for this study were chi square and Poisson Regression plus the Negative Binomial Regression. Because the data for this study came from a database, I did not need to account for protection human participants because I had no direct contact with the patients, and the identifiers were deleted throughout the dissertation process by the New Jersey Department of Health. The data analyses for this study were conducted using the Statistical Package for the Social Sciences. The results of this study can be published in a peer-reviewed journal and be presented at a professional conference. The occurrence of this study can produce results. I present the results of the study Chapter 4.

Chapter 4: Results

Introduction

The purpose of this study was to determine the relationship of selected social determinants on tuberculosis incidence over a period of nearly 2 decades at the state level. The study was designed to answer the following research question: What is the association between tuberculosis incidence trend with gender, place of birth, substance abuse, and place of residence? As the relationship between these predictor variables and tuberculosis rates may depend upon the age group (i.e., effect modification by age group), the relationships were explored within age strata.

This chapter is organized as follows: I begin by describing the data collection process and study sample, including the time frame for data collection, the discrepancies between the planned and actual approach, the descriptive and demographic characteristics of the sample, how representative the sample is, and the results of basic univariate analysis. Next, I describe of the results of the research starting with descriptive statistics results, assumptions, and the statistical analysis findings organized by the research questions. I close the chapter with a summary of the results.

Data Collection

Time Frame for Data Collection

The data for this study were collected by the New Jersey Department of Health Tuberculosis Program through which information on tuberculosis trends in the state were maintained for a rolling 20-year period. Thus, I sought to use data for the years 1993-2012, (i.e., the most recent period for which data were available).

Discrepancies in Data Collection from Plan Presented in Chapter 3

Discrepancies were found in the data, relative to what was anticipated (and described in Chapter 3), in the following areas: sample size, data collection, and arrangement of data elements. With regard to the sample size, I had expected a sample size of over 12,000 individuals based upon reported data from the New Jersey Department of Health. However, the actual number of patients for whom I received data on was under 10,000 (nearly 17% reduction of the expected) because of omitted cases. For data collection, I assumed that the data elements were collected in a uniform manner for all patients over the entire study time period, but I found that some of the data elements for individuals were not collected. In particular, for the earliest years of the study (i.e., 1993 and 1994), data elements of interest (e.g., place of birth, gender, and substance abuse) were not reported for many patients resulting in a decrease in the effective sample size for these years of 691 (loss of 75.8%) and 777 (90.9% decrease) cases, respectively. The reason for the missing or omitted cases is not known. Some of the data for those lost cases had to be missing or omitted from the case profiles.

To deal with possible bias and erroneous statistical analyses for this study related to the years 1993 and 1994, I elected to only analyze data from 1995-2012. The first reason for removing these cases is that I do not know what elements were missing or were omitted from the original 1993 and 1994 case profiles. For example, in all cases in 1993 and 1994, I knew where the individual in each case resided, mainly which county that person dwelled. The substance abuse status, which is not published by the state Tuberculosis Program, was mostly unknown for each individual for those years. The second reason for the removal of those years is because I do not know whether the cases that I had been given for those years are a true representation of all of the possible patients with tuberculosis. The data that are accessible to the public show that the tuberculosis morbidity cases were distributed across all state counties, but the data that I received show did not covered all counties (e.g., data for 1993 included only 67% counties and data for 1994 included only 81% of covered counties).

Basic Descriptive and Demographic Characteristics of the Study Sample

There were a total of 9,518 cases from 1995 to 2012. The mean age was 44.3 (SD=20.4) years, median of 42.0 years, and the age range was from 0 years (under 12 months of age) to 100 years of age. As age may interact with other variables and tuberculosis incidence, the analyses were performed according to six clinically meaningful age categories: 0 to 4 years (2.4%), 5 to 14 years (2.6%), 15 to 24 years (10.3%), 25 to 44 years (40.2%), 45 to 64 years (25.7%), and 65 years and over (18.9%).

The majority of patients were males (*n*= 5,502 male, 57.8%) and 42.2% (*n*= 4,016) were females. Twice as many cases were foreign-born (outside of the United States) vs. being born in the United States (62.8% vs. 36.2%). For the research question about residence, there was nearly a 4 to 1 ratio for those residents who were classified as "high" (those counties with median housing prices that are above the prestudy-calculated average median housing prices). Nonsubstance abusers represent the vast majority of the patients compared with substance abusers (86.1% versus 13.9%; Table 1).

The results presented are reflective of published data (by the New Jersey Department of Health) on tuberculosis figures in the state.

Table 1

Descriptive and Demographic Characteristics of Sample

Sample size			9518	
Gender		Male	5502	57.8%
		Female	4016	42.2%
Age (in years)		Mean	44.4±20.4	
		Range	0 - 100	
	Age groups	0 to 4 years	225	2.4%
		5 to 14	246	2.6%
		15 to 24	978	10.3%
		25 to 44	3824	40.2%
		45 to 64	2450	25.7%
		65+	1795	18.9%
Gender - Age(years)	Male	Mean	45.1±19.7	
	Female	Mean	43.2±21.2	
Place of Birth		U.S. born	3497	36.8%
		Foreign born	6014	63.2%
Substance Abuse		Abusers	1316	13.9%
		Non-abusers	8126	86.1%
Residence		Low	1666	17.5%
		High	7852	82.5%

Note. High = county median housing price above average median housing price

Results

The results of this study are presented according to the research questions. The research questions included the association (a) between gender and tuberculosis incidence trend, (b) between place of birth and tuberculosis incidence trend, (c) substance abuse and tuberculosis incidence trend, and (d) residence and tuberculosis incidence trend. Each research question was analyzed by Mantel-Haenszel extension of the chi-square test for trend, the Poisson Regression, and the Negative Binomial Regression; and the results from these quantitative procedures are presented under the heading that pertains to the given research question.

Statistical Assumptions

The statistical assumptions for the Mantel-Haenszel extension of chi-square test for trend have four components. The first component is that the variables, whether independent or dependent, are categorical with two or more levels. The next is that the levels are ordered. The third is that the data are frequencies. The final component is that each observation belongs in an unique cell (Pett,1997). Thus, the statistical assumptions for the Mantel-Haenszel extension of the chi-square test for trend can be seen as being fulfilled for this study.

The statistical assumptions for the Poisson Regression are similar to the Mantel-Haenszel extension of the chi-square test for trend. The first statistical assumption is the independence of the observations. The next assumption is that the changes in rates from combined effects of exposures are multiplicative. Another assumption is that the logarithm of the disease rate changes linearly with equal increment increases in the exposure variable (Poisson Regression Analysis, n.d.). One final assumption to note is that the number of cases has variance equal to the mean (Poisson Regression Analysis, n.d.). However, the assumption of the variance being equal to the mean for the Poisson Regression cannot be proven at times. Because there is no statistical test that can validate variance and mean equivalent, the Negative Binomial Regression is sometimes used instead (Piza, 2012). The Negative Binomial Regression has the same assumptions of the Poisson Regression except that the variance does not have to equal to the mean (McNamee, 2005; Piza, 2012). In this study, both the Poisson and the Negative Binomial Regressions are used. To achieve the best model for regression and to see the best relationship between the independent variable (i.e., gender, place of birth, substance abuse, or residence) and the dependent variable (tuberculosis incidence), both regressions were run (Piza, 2012).

Association between Gender and Tuberculosis Incidence Trend

The first research question dealt with the association of gender and tuberculosis incidence trend. The Mantel-Haenszel extension of the chi-square test for trend showed different results for the age groups. For the 0 to 4; 5 to 14; 15 to 24; and 65 years and over age groups, there were no significant associations between gender and tuberculosis incidence trend ($p > .05$). There were significant associations, however, between gender and tuberculosis incidence trend for persons aged 25 to 44 years and for persons aged 45 to 64 years (both with $p < .05$). For the comprehensive analysis, there was a significant association between gender and tuberculosis incidence trend $p < .05$ (Table 2).

Table 2

Association between Gender and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend

Age Group (in years)	MHecstt value
0 to 4	0.0
5 to 14	0.7
15 to 24	0.0
25 to 44	13.9*
45 to 64	2.2
65 +	0.5
Overall	9.0*

Note. *$p < .05$; MHecstt = Mantel-Haenszel extension of the chi-square test for trend

To further analyze the trends, the odds ratios pattern for each age group and the comprehensive analysis was calculated. For the 0 to 4 years age group, there was no noticeable pattern; $p > .05$ (Table 3).

Table 3

Association between Gender and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 0 to 4 years Age Group

Year of detection	Male	Female	Odds Ratio
1995	5	5	1
1996	7	6	1.17
1997	9	7	1.29
1998	13	11	1.18
1999	3	9	0.33
2000	8	4	2.00
2001	7	4	1.75
2002	8	13	0.62
2003	6	9	0.67
2004	9	11	0.82
2005	4	8	0.25
2006	4	3	1.33
2007	11	8	1.38
2008	2	0	∞
2009	3	6	0.50
2010	8	6	1.33
2011	3	4	0.75
2012	1	0	∞

For the 5 to 14 years age group, there was no pattern; $p > .05$ (Table 4).

Table 4

Association between Gender and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 5 to 14 Years Age Group

Year of detection	Male	Female	Odds Ratio
1995	19	16	1
1996	12	10	1.01
1997	16	17	0.79
1998	8	10	0.67
1999	6	6	0.84
2000	8	4	1.68
2001	2	12	0.14
2002	5	5	0.84
2003	4	8	0.42
2004	6	6	0.84
2005	6	6	0.84
2006	3	5	0.51
2007	5	6	0.70
2008	5	2	2.11
2009	3	2	1.26
2010	5	7	0.60
2011	2	5	0.34
2012	2	2	0.84

With the 15 to 24 years age group, there was no noticeable pattern; $p > .05$ (Table 5).

Table 5

Association between Gender and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for15 to 24 Years Age Group

Year of detection	Male	Female	Odds Ratio
1995	24	21	1
1996	31	25	1.08
1997	33	27	1.07
1998	29	21	1.20
1999	34	25	1.19
2000	25	43	0.51
2001	36	28	1.12
2002	35	21	1.46
2003	39	31	1.10
2004	28	31	0.79
2005	43	27	1.39
2006	33	30	0.96
2007	32	26	1.08
2008	22	19	1.01
2009	30	26	1.01
2010	20	24	0.73
2011	19	16	1.04
2012	14	10	1.22

As for the age group of 25 to 44 years, there were short trends of 3 to 5 years with two intervals of increasing odds ratio values from 2000 to 2002 and from 2003 to 2006, and one interval of decreasing odds ratio values from 2008 to 2012; $p < .001$ (Table 6).

Table 6

Association between Gender and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 25 to 44 Years Age Group

Year of detection	Male	Female	Odds Ratio
1995	215	128	1
1996	206	145	0.85
1997	168	116	0.86
1998	143	117	0.73
1999	142	82	1.03
2000	116	95	0.73
2001	133	93	0.85
2002	129	85	0.90
2003	102	95	0.64
2004	110	93	0.70
2005	100	85	0.70
2006	122	100	0.73
2007	89	85	0.62
2008	111	66	1.00
2009	91	78	0.69
2010	74	65	0.68
2011	64	59	0.65
2012	51	71	0.43

For the 45 to 64 years age group, there was no trend; $p > .05$ (Table 7).

Table 7

Association between Gender and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for trend for 45 to 64 Years Age Group

Year of detection	Male	Female	Odds Ratio
1995	163	84	1
1996	154	57	1.39
1997	110	68	0.83
1998	110	52	1.09
1999	95	57	0.86
2000	95	53	0.92
2001	65	46	0.73
2002	83	53	0.81
2003	59	60	0.51
2004	60	54	0.57
2005	87	39	1.15
2006	85	36	1.22
2007	75	46	0.84
2008	75	47	0.82
2009	57	40	0.73
2010	71	42	0.87
2011	50	36	0.72
2012	62	24	1.33

With the 65 years and over age group, there was no observable trend; $p > .05$ (Table 8).

Table 8

Association between Gender and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 65 Years and Over Age Group

Year of detection	Male	Female	Odds Ratio
1995	101	66	1
1996	77	90	0.56
1997	86	60	0.94
1998	71	53	0.88
1999	63	48	0.86
2000	64	50	0.84
2001	61	43	0.93
2002	57	35	1.06
2003	50	32	1.02
2004	45	29	1.01
2005	46	34	0.88
2006	52	35	0.97
2007	46	38	0.79
2008	37	36	0.67
2009	35	34	0.67
2010	55	28	1.28
2011	36	37	0.64
2012	43	22	1.28

With the comprehensive analysis, there was a slight trend of increasing odd ratio values over time; $p < .001$ (Table 9).

Table 9

Association between Gender and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for Comprehensive Analysis

Year of detection	Male	Female	Odds Ratio
1995	527	320	1
1996	487	333	0.89
1997	422	295	0.87
1998	374	264	0.86
1999	343	227	0.92
2000	316	249	0.77
2001	304	226	0.82
2002	317	212	0.91
2003	260	235	0.67
2004	258	224	0.70
2005	286	199	0.87
2006	299	209	0.87
2007	258	209	0.75
2008	252	170	0.90
2009	219	186	0.71
2010	233	172	0.82
2011	174	157	0.67
2012	173	129	0.81

With the Poisson Regression dealing with the research question of gender and tuberculosis incidence trend, the results were somewhat different. The difference showed as having no significant association between any gender and tuberculosis incidence trend with regards to slopes of the covariates $p > .05$ (Table 10). The model was composed of the intercept, client's (patient's) age, year of detection, and the interaction between the client's age and the year of detection.

Table 10

Association between Gender and Tuberculosis Incidence Trend: Poisson Regression Analysis

Covariate	Parameter	B	95 % CI LL	95 % CI UL	*p*
Male					
	Intercept	0.0	-26.3	26.3	1.0
Client age	Slope	0.0	-0.5	0.5	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0
Female					
	Intercept	0.0	-19.1	20.4	0.9
Client age	Slope	0.0	-0.4	0.4	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0

Notes. LL = Lower Limit; UL = Upper Limit; CI = Confidence Intervals; *p* = significance

The Negative Binomial Regression showed no significant association between gender and tuberculosis incidence trend (slope $p > .05$), similar to the Poisson model (Table 11).

Table 11

Association between Gender and Tuberculosis Incidence Trend: Negative Binomial Regression Analysis

			95 % CI		
Covariate	Parameter	B	LL	UL	*p*
Male					
	Intercept	0.0	-37.1	37.1	1.0
Client age	Slope	0.0	-0.7	0.7	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0
Female					
	Intercept	0.7	-33.5	20.4	1.0
Client age	Slope	0.0	-0.7	0.7	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0

Notes. LL = Lower Limit; UL = Upper Limit; CI = Confidence Intervals; *p* = significance

Association between Place of Birth and Tuberculosis Incidence Trend

The second research question looked at the association between place of birth and tuberculosis incidence trend. For the age groups of 0 to 4 years and 5 to 14 years, there were no significant associations between place of birth and tuberculosis incidence trend $p > .05$. With the age groups of 15 to 24 years, 25 to 44 years, 45 to 64 years, and 65 years and over, there were significant associations between place of birth and tuberculosis incidence trend $p < .05$ and trends were present. For the comprehensive analysis, there was significant association between place of birth and tuberculosis incidence trend $p < .05$ and a trend for this research question (Table 12).

Table 12

Association between Place of Birth and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend

Age Group (in years)	MHecstt value
0 to 4	0.2
5 to 14	1.0
15 to 24	5.6*
25 to 44	381.5*
45 to 64	128.0*
65 +	116.7*
Overall	554.2*

Note. *$p < .05$; MHecstt = Mantel-Haenszel extension of chi-square test for trend

To visualize the trends, the odds ratios pattern for each age group and the comprehensive analysis was calculated. For the 0 to 4 years age group, there was no noticeable pattern; $p > .05$ (Table 13).

Table 13

Association between Place of Birth and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 0 to 4 years age group

Year of detection	US Born	Foreign Born	Odds Ratio
1995	10	0	1
1996	11	2	0
1997	15	1	0
1998	22	2	0
1999	10	2	0
2000	11	1	0
2001	9	2	0
2002	21	0	∞
2003	13	2	0
2004	19	1	0
2005	11	1	0
2006	7	0	∞
2007	17	2	0
2008	2	0	∞
2009	8	1	0
2010	13	1	0
2011	7	0	∞
2012	1	0	∞

Note. US born = born in the US; foreign born = born outside the US

For the 5 to 14 years age group, there was no trend; $p > .05$ (Table 14).

Table 14

Association between Place of Birth and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 5 to 14 Years Age Group

Year of detection	US Born	Foreign Born	Odds Ratio
1995	25	10	1
1996	17	5	1.36
1997	18	15	0.48
1998	6	12	0.20
1999	7	5	0.56
2000	6	6	0.40
2001	8	6	0.53
2002	4	6	0.27
2003	6	6	0.40
2004	11	1	4.40
2005	5	7	0.28
2006	4	4	0.40
2007	8	3	1.07
2008	4	3	0.53
2009	5	0	∞
2010	8	4	0.80
2011	7	0	∞
2012	3	1	1.20

Note. US born = born in the US; foreign born = born outside the US

With the 15 to 24 years age group, there was no observable pattern; p = .01 (Table 15).

Table 15

Association between Place of Birth and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 15 to 24 Years Age group

Year of detection	US Born	Foreign Born	Odds Ratio
1995	20	25	1
1996	15	41	0.46
1997	15	45	0.42
1998	5	45	0.14
1999	8	51	0.20
2000	8	59	0.17
2001	6	58	0.13
2002	8	48	0.21
2003	6	64	0.12
2004	9	50	0.22
2005	10	60	0.21
2006	11	52	0.26
2007	10	48	0.26
2008	5	36	0.17
2009	9	47	0.24
2010	6	38	0.20
2011	9	26	0.43
2012	3	21	0.18

Note. US born = born in the US; foreign born = born outside the US

As for the age group of 25 to 44 years, there were weak trends of 5-year cluster from 1999 to 2003 with odds ratio values decreasing over time; $p < .001$ (Table 16).

Table 16

Association between Place of Birth and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 25 to 44 Years Age Group

Year of detection	US Born	Foreign Born	Odds Ratio
1995	184	159	1
1996	150	201	0.64
1997	130	154	0.73
1998	101	159	0.55
1999	78	146	0.86
2000	61	150	0.35
2001	56	169	0.29
2002	49	164	0.26
2003	23	173	0.11
2004	31	172	0.16
2005	40	145	0.24
2006	32	190	0.15
2007	18	156	0.10
2008	26	151	0.15
2009	17	152	0.10
2010	17	122	0.12
2011	9	113	0.07
2012	8	114	0.06

Note. US born = born in the US; foreign born = born outside the US

With the age group of 45 to 64 years, there were trends of mostly 3-year clusters, from1998 to 2001, from 2002 to 2004, from 2005 to 2007, and from 2008 to 2010 with an overall pattern of decreasing odds ratio values; p <.001 (Table 17).

Table 17

Association between Place of Birth and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 45 to 64 Years Age Group

Year of detection	US Born	Foreign Born	Odds Ratio
1995	144	103	1
1996	118	93	0.91
1997	97	81	0.86
1998	93	69	0.96
1999	68	84	0.58
2000	60	88	0.49
2001	44	67	0.47
2002	64	71	0.64
2003	44	75	0.42
2004	40	74	0.39
2005	52	74	0.50
2006	38	83	0.33
2007	33	88	0.27
2008	40	82	0.35
2009	31	66	0.34
2010	27	86	0.22
2011	25	61	0.29
2012	15	71	0.15

Note. US born = born in the US; foreign born = born outside the US

For the 65 years and over age group, there was a slight trend observed with decreasing odds ratio values over time; $p < .001$ (Table 18).

Table 18

Association between Place of Birth and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 65 Years and Over Age Group

Year of detection	US Born	Foreign Born	Odds Ratio
1995	124	43	1
1996	108	59	0.63
1997	87	59	0.51
1998	76	48	0.55
1999	60	50	0.42
2000	59	55	0.37
2001	59	45	0.45
2002	49	43	0.40
2003	42	40	0.36
2004	29	29	0.35
2005	40	40	0.35
2006	31	56	0.19
2007	27	57	0.16
2008	20	53	0.13
2009	26	43	0.21
2010	31	52	0.21
2011	25	48	0.18
2012	19	46	0.14

Note. US born = born in the US; foreign born = born outside the US

With the comprehensive analysis, there was a trend for the start to the end of the time period with an overall pattern of decreasing odds ratio values; $p < .001$ (Table 19).

Table 19

Association between Place of Birth and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for the Comprehensive Analysis

Year of detection	US Born	Foreign Born	Odds Ratio
1995	507	340	1
1996	419	401	0.70
1997	362	355	0.68
1998	303	335	0.61
1999	231	338	0.46
2000	205	359	0.38
2001	182	347	0.35
2002	195	332	0.39
2003	134	360	0.25
2004	139	343	0.27
2005	158	327	0.32
2006	123	385	0.21
2007	113	354	0.21
2008	97	325	0.20
2009	96	309	0.21
2010	102	303	0.22
2011	82	248	0.22
2012	49	253	0.13

Note. US born = born in the US; foreign born = born outside the US

The second research question of place of birth and tuberculosis incidence trend was analyzed by way of Poisson regression. For U.S. born patients, there were no significant associations between place of birth and tuberculosis incidence trend for any parameter covariates (p >.05). For the foreign born patients, there were no significant associations between place of birth and tuberculosis incidence trend for slopes of the covariates p >.05 (Table 20).

Table 20

Association between Place of Birth and Tuberculosis Incidence Trend: Poisson Regression Analysis

			95 % CI		
Covariate	Parameter	B	LL	UL	*p*
US Born					
	Intercept	0.0	-30.9	30.9	1.0
Client age	Slope	0.0	-0.6	0.6	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0
Foreign Born					
	Intercept	0.7	-33.5	20.4	0.9
Client age	Slope	0.0	-0.4	0.4	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0

Note. LL = Lower Limit; UL = Upper Limit; CI = Confidence Intervals; *p* = significance

The second research question of place of birth and tuberculosis incidence trend was viewed by way of Negative Binomial Regression (slope p >.05), which revealed similar results to the Poisson model (Table 21).

Table 21

Association between Place of Birth and Tuberculosis Incidence Trend: Negative Binomial Regression Analysis

			95 % CI		
Covariate	Parameter	B	LL	UL	*p*
US Born					
	Intercept	0.0	-43.7	43.7	1.0
Client age	Slope	0.0	-0.6	0.6	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0
Foreign Born					
	Intercept	0.7	-30.6	31.9	1.0
Client age	Slope	0.0	-0.7	0.7	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0

Note. LL = Lower Limit; UL = Upper Limit; CI = Confidence Intervals; p = significance

Association between Substance Abuse and Tuberculosis Incidence Trend

The third research question on the association between substance abuse and tuberculosis incidence trend showed the results for the six age groups. The Mantel-Haenszel extension of the chi-square test for trend was examined for the six age groups. For the 0 to 4 years age group, there was no statistics computed because there were no patients for this age group who were classified as abusers. With the 5 to 14 years, 15 to 24 years, and 65 years and over age groups, there were no significant associations between substance abuse and tuberculosis incidence trend $p > .05$. For 25 to 44 years and 45 to 64 years age groups, there were significant associations between substance abuse and tuberculosis incidence trend $p < .05$ and trends for these age groups. For the comprehensive analysis, there was significant association between substance abuse and tuberculosis incidence trend $p < .05$ and a trend for this research question (Table 22).

Table 22

Association between Substance Abuse and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend

Age Group (in years)	MHecstt value
0 to 4	.[a]
5 to 14	0.6
15 to 24	0.1
25 to 44	178.1*
45 to 64	18.3*
65 +	2.3
Overall	158.0*

Note. a. No statistics are computed, $^*p < .05$; MHecstt = Mantel-Haenszel extension of the chi-square test for trend

To investigate the trends, the odds ratios pattern for each age group and the comprehensive analysis was calculated. For the 0 to 4 years age group, there was no trend to be calculated because of no data were available for the substance abusers and thus, no statistics were computed (Table 23).

Table 23

Association between Substance Abuse and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 0 to 4 Years Age Group

Year of detection	Abuser	Non-Abuser	Odds Ratio
1995	0	10	1
1996	0	13	∞
1997	0	16	∞
1998	0	24	∞
1999	0	12	∞
2000	0	12	∞
2001	0	11	∞
2002	0	21	∞
2003	0	15	∞
2004	0	20	∞
2005	0	12	∞
2006	0	7	∞
2007	0	19	∞
2008	0	2	∞
2009	0	9	∞
2010	0	14	∞
2011	0	7	∞
2012	0	1	∞

Note. Non-abuser = do not use drugs; abuser = user of drugs

For the age group of 5 to 14 years, there was no trend; p >.05 (Table 24).

Table 24

Association between Substance Abuse and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 5 to 14 Years Age Group

Year of detection	Abuser	Non-Abuser	Odds Ratio
1995	0	35	1
1996	0	22	∞
1997	0	33	∞
1998	0	18	∞
1999	0	12	∞
2000	0	12	∞
2001	0	14	∞
2002	0	10	∞
2003	0	12	∞
2004	0	12	∞
2005	1	11	∞
2006	0	8	∞
2007	0	11	∞
2008	0	7	∞
2009	0	5	∞
2010	0	12	∞
2011	0	7	∞
2012	0	4	∞

Note. Non-abuser = do not use drugs; abuser = user of drugs

With the 15 to 24 years age group, there was no pattern; $p > .05$ (Table 25).

Table 25

Association between Substance Abuse and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 15 to 24 Years Age Group

Year of detection	Abuser	Non-Abuser	Odds Ratio
1995	2	43	1
1996	2	52	0.83
1997	2	57	0.75
1998	4	46	1.87
1999	4	55	1.56
2000	2	65	0.66
2001	2	62	0.69
2002	3	52	1.13
2003	3	67	0.96
2004	7	52	3.01
2005	2	68	0.63
2006	1	62	0.35
2007	4	54	1.59
2008	1	40	0.54
2009	2	54	0.80
2010	0	43	0
2011	2	33	1.30
2012	2	22	1.95

Note. Non-abuser = do not use drugs; abuser = user of drugs

As for the 25 to 44 years age group, there was a weak trend with an overall pattern of decreasing odds ratio values; $p < .001$ (Table 26).

Table 26

Association between Substance Abuse and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 25 to 44 Years Age Group

Year of detection	Abuser	Non-Abuser	Odds Ratio
1995	105	238	1
1996	100	241	0.94
1997	80	196	0.93
1998	69	191	0.82
1999	57	164	0.79
2000	36	173	0.47
2001	39	183	0.48
2002	30	181	0.38
2003	23	172	0.30
2004	19	184	0.23
2005	24	161	0.34
2006	21	200	0.24
2007	14	160	0.20
2008	19	158	0.27
2009	12	157	0.17
2010	8	131	0.14
2011	14	108	0.29
2012	8	114	0.16

Note. Non-abuser = do not use drugs; abuser = user of drugs

As for the 45 to 64 years age group, the odds ratio values fluctuated over time; $p < .001$ (Table 27).

Table 27

Association between Substance Abuse and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 45 to 64 Years Age Group

Year of detection	Abuser	Non-Abuser	Odds Ratio
1995	62	185	1
1996	55	151	1.09
1997	39	139	0.84
1998	48	113	1.27
1999	36	116	0.93
2000	31	116	0.80
2001	28	83	1.01
2002	32	101	0.95
2003	31	87	1.06
2004	15	99	0.45
2005	26	100	0.78
2006	18	103	0.52
2007	18	103	0.52
2008	21	101	0.62
2009	20	77	0.78
2010	17	96	0.53
2011	13	73	0.53
2012	16	70	0.68

Note. Non-abuser = do not use drugs; abuser = user of drugs

With the 65 years and over age group, there was no trend; $p > .05$ (Table 28).

Table 28

Association between Substance Abuse and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 65 Years and Over Age Group

Year of detection	Abuser	Non-Abuser	Odds Ratio
1995	7	160	1
1996	11	146	1.72
1997	6	132	1.04
1998	3	121	0.57
1999	5	106	1.08
2000	3	109	0.63
2001	4	100	0.91
2002	4	85	1.08
2003	4	76	1.20
2004	1	73	0.31
2005	1	79	0.29
2006	1	86	0.27
2007	4	80	1.14
2008	4	69	1.33
2009	2	67	0.68
2010	2	81	0.56
2011	3	70	0.98
2012	1	64	0.36

Note. Non-abuser = do not use drugs; abuser = user of drugs

For the comprehensive analysis, there were weak patterns with an overall pattern of decreasing odds ratio values; p <.001 (Table 29).

Table 29

Association between Substance Abuse and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for Comprehensive Analysis

Year of detection	Abuser	Non-Abuser	Odds Ratio
1995	176	671	1
1996	168	625	1.02
1997	127	573	0.84
1998	124	513	0.92
1999	102	465	0.84
2000	72	487	0.56
2001	73	453	0.61
2002	69	450	0.58
2003	61	429	0.54
2004	42	440	0.36
2005	54	431	0.48
2006	41	466	0.34
2007	40	427	0.36
2008	45	377	0.46
2009	36	369	0.37
2010	27	377	0.27
2011	32	298	0.41
2012	27	275	0.37

Note. Non-abuser = do not use drugs; abuser = user of drugs

For the Poisson Regression, I divided the data into substance abuse groups. For abusers, there were no significant association between substance abuse and tuberculosis incidence trend for the covariates (slopes $p > .05$). For the non-abusers, there were no significant association between substance abuse and tuberculosis incidence trend for the covariates slopes and interaction $p > .05$ (Table 30).

Table 30

Association between Substance Abuse and Tuberculosis Incidence Trend: Poisson Regression Analysis

Covariate	Parameter	B	95 % CI LL	95 % CI UL	*p*
Abuser					
	Intercept	0.0	-87.0	84.0	1.0
Client age	Slope	0.0	-1.9	1.8	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0
Non-Abuser					
	Intercept	0.7	-13.4	14.8	0.9
Client age	Slope	0.0	-0.3	0.3	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0

Note. LL = Lower Limit; UL = Upper Limit; CI = Confidence Intervals; *p* = significance

The Negative Binomial Regression showed no significant association between substance abuse and tuberculosis incidence trend (slope p >.05), similar to the Poisson model (Table 31).

Table 31

Association between Substance Abuse and Tuberculosis Incidence Trend: Negative Binomial Regression Analysis

			95 % CI		
Covariate	Parameter	B	LL	UL	*p*
Abuser					
	Intercept	0.0	-123.1	123.1	1.0
Client age	Slope	0.0	-2.7	2.7	1.0
Year detected	Slope	0.0	-0.1	0.1	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0
Non-Abuser					
	Intercept	0.7	-23.7	25.0	1.0
Client age	Slope	0.0	-0.5	0.5	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0

Note. LL = Lower Limit; UL = Upper Limit; CI = Confidence Intervals; p = significance

Association between Residence and Tuberculosis Incidence Trend

The final research question that I dealt with was the association of residence with tuberculosis incidence trend. I divided the data into age group for Mantel-Haenszel extension of the chi-square test for trend. For the patients in 0 to 4 years, 5 to 14 years, and 25 to 44 years age groups, there were significant associations between residence and tuberculosis incidence trend $p < .05$ and trends for these age groups. With the age groups of 45 to 64 years and 65 years and over, there were no significant associations between residence and tuberculosis incidence trend $p > .05$. For the comprehensive analysis, there was significant association between residence and tuberculosis incidence trend $p < .05$ and a trend for this research question (Table 32).

Table 32

Association between Residence and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend

Age Group (in years)	MHecstt value
0 to 4	12.1*
5 to 14	6.2*
15 to 24	9.4*
25 to 44	10.0*
45 to 64	2.5
65 +	1.4
Overall	13.7*

Note. *p <.05; MHecstt = Mantel-Haenszel extension of the chi-square test for trend

To further analyze the trends, the odds ratios pattern for each of the age groups and the comprehensive analysis was calculated. For the 0 to 4 years age group, there was no true trend; p =.00 (Table 33).

Table 33

Association between Residence and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 0 to 4 Years Age Group

Year of detection	Low	High	Odds Ratio
1995	0	10	1
1996	0	13	∞
1997	1	15	∞
1998	4	20	∞
1999	0	12	∞
2000	1	11	∞
2001	2	9	∞
2002	1	20	∞
2003	1	14	∞
2004	1	19	∞
2005	1	11	∞
2006	3	4	∞
2007	3	16	∞
2008	0	2	∞
2009	2	7	∞
2010	5	9	∞
2011	3	4	∞
2012	0	1	∞

Note. Low = medium housing price below the pre-study calculated average medium housing price; High = medium housing price above the pre-study calculated average medium housing price

For the 5 to 14 years age group, there were clusters of trend with an overall pattern of fluctuating odds ratio values; p =.01 (Table 34).

Table 34

Association between Residence and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 5 to 14 Years Age Group

Year of detection	Low	High	Odds Ratio
1995	4	31	1
1996	3	19	1.22
1997	5	28	1.38
1998	2	16	0.97
1999	4	8	3.88
2000	1	11	0.70
2001	4	10	3.10
2002	0	10	0
2003	2	10	1.55
2004	4	8	3.88
2005	1	11	0.70
2006	2	6	2.58
2007	4	7	4.42
2008	3	4	5.81
2009	2	3	5.17
2010	2	10	1.55
2011	2	5	3.10
2012	2	2	7.75

Note. Low = medium housing price below the pre-study calculated average medium housing price; High = medium housing price above the pre-study calculated average medium housing price

For the age group of 15 to 24 years, there were a few short trends; 3- to 5-year runs from 1997 to 2000, from 2002 to 2004, and from 2007 to 2009 with an overall pattern of fluctuating odds ratio values; p <.001 (Table 35).

Table 35

Association between Residence and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 15 to 24 Years Age Group

Year of detection	Low	High	Odds Ratio
1995	3	42	1
1996	3	53	0.79
1997	9	51	2.47
1998	7	43	2.28
1999	7	52	1.88
2000	6	62	1.35
2001	7	57	1.72
2002	11	45	3.42
2003	11	59	2.61
2004	7	52	1.88
2005	19	51	5.22
2006	12	51	3.29
2007	13	45	4.04
2008	8	33	3.39
2009	9	47	2.68
2010	10	34	4.12
2011	3	32	1.31
2012	5	19	3.68

Note. Low = medium housing price below the pre-study calculated average medium housing price; High = medium housing price above the pre-study calculated average medium housing price

With the 25 to 44 years age group, there were three short trends with fluctuating odds ratio values of 4 years, from 1997 to 2000, from 2002 to 2005, and from 2005 to 2008; p <.001 (Table 36).

Table 36

Association between Residence and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 25 to 44 Years Age Group

Year of detection	Low	High	Odds Ratio
1995	43	300	1
1996	64	287	1.56
1997	26	258	0.70
1998	32	228	0.98
1999	29	195	1.04
2000	35	176	1.38
2001	35	191	1.28
2002	29	185	1.09
2003	35	162	1.51
2004	38	165	1.61
2005	35	150	1.63
2006	39	183	1.49
2007	29	145	1.40
2008	27	150	1.26
2009	37	132	1.96
2010	27	112	1.68
2011	26	97	1.87
2012	16	106	1.05

Note. Low = medium housing price below the pre-study calculated average medium housing price; High = medium housing price above the pre-study calculated average medium housing price

As for the age group of 45 to 64 years, there was no pattern; $p > .05$ (Table 37).

Table 37

Association between Residence and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 45 to 64 Years Age Group

Year of detection	Low	High	Odds Ratio
1995	37	210	1
1996	33	178	1.05
1997	41	137	1.70
1998	25	137	1.04
1999	31	121	1.45
2000	30	118	1.44
2001	17	94	1.03
2002	22	114	1.10
2003	21	98	1.22
2004	15	99	0.86
2005	27	99	1.55
2006	30	91	1.87
2007	23	98	1.33
2008	20	102	1.11
2009	13	84	0.88
2010	28	85	1.87
2011	23	63	2.07
2012	15	71	1.20

Note. Low = medium housing price below the pre-study calculated average medium housing price; High = medium housing price above the pre-study calculated average medium housing price

With the age group of 65 years and over, there was no trend; $p > .05$ (Table 38).

Table 38

Association between Residence and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for 65 Years and Over Age Group

Year of detection	Low	High	Odds Ratio
1995	46	121	1
1996	28	139	0.05
1997	30	116	0.68
1998	37	87	1.12
1999	25	86	0.76
2000	26	88	0.78
2001	22	82	0.70
2002	25	67	0.98
2003	12	70	0.45
2004	12	62	0.51
2005	15	65	0.61
2006	16	71	0.59
2007	20	64	0.82
2008	12	61	0.52
2009	19	50	1.00
2010	14	69	0.53
2011	11	62	0.47
2012	18	47	1.01

Note. Low = medium housing price below the pre-study calculated average medium housing price; High = medium housing price above the pre-study calculated average medium housing price

As for the comprehensive analysis, there was an overall increase in odds ratios over time; $p < .001$ (Table 39).

Table 39

Association between Residence and Tuberculosis Incidence Trend: Mantel-Haenszel Extension of the Chi-Square Test for Trend for Comprehensive Analysis

Year of detection	Low	High	Odds Ratio
1995	133	714	1
1996	131	689	1.02
1997	112	605	0.99
1998	107	531	1.08
1999	96	474	1.09
2000	99	466	1.14
2001	87	443	1.05
2002	88	441	1.07
2003	82	413	1.07
2004	77	405	1.02
2005	98	387	1.36
2006	102	406	1.35
2007	92	375	1.32
2008	70	352	1.07
2009	82	323	1.36
2010	86	319	1.45
2011	68	263	1.39
2012	56	246	1.22

Note. Low = medium housing price below the pre-study calculated average medium housing price; High = medium housing price above the pre-study calculated average medium housing price

The Poisson Regression model for residence was based on results with the foundation on median housing prices in each county. I split the data file into residence sets to do the Poisson Regression. For the "low" residence, there were no significant associations between residence and tuberculosis incidence trend for the covariates slopes and interaction p >.05. With the "high" residence, there were no significant associations between residence and tuberculosis incidence trend for the covariates slopes and interaction p >.05 (Table 40).

Table 40

Association between Residence and Tuberculosis Incidence Trend: Poisson Regression Analysis

Covariate	Parameter	B	95 % CI LL	95 % CI UL	*p*
Low					
	Intercept	0.0	-46.3	46.3	1.0
Client age	Slope	0.0	-0.8	0.8	1.0
Year detected	Slope	0.0	-0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0
High					
	Intercept	0.7	-14.2	15.6	0.9
Client age	Slope	0.0	-0.3	0.3	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0

Note. LL = Lower Limit; UL = Upper Limit; CI = Confidence Intervals; *p* = significance

The Negative Binomial Regression showed no significant association between residence and tuberculosis incidence trend (slope p >.05), similar to the Poisson model (Table 41). These were the results of my research questions.

Table 41

Association between Residence and Tuberculosis Incidence Trend: Negative Binomial Regression Analysis

			95 % CI		
Covariate	Parameter	B	LL	UL	*p*
Low					
	Intercept	0.0	-65.5	65.5	1.0
Client age	Slope	0.0	-1.2	1.2	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0
High					
	Intercept	0.7	-25.1	26.5	1.0
Client age	Slope	0.0	-0.5	0.5	1.0
Year detected	Slope	0.0	0.0	0.0	1.0
Client age*Year detected	Interaction	0.0	0.0	0.0	1.0

Note. LL = Lower Limit; UL = Upper Limit; CI = Confidence Intervals; *p* = significance

Summary

The foundation for my discussion chapter was set up by the results of my research questions. Those results showed the existence of trends but no information on direction. The findings from the Mantel-Haenszel extension of the chi-square test for trend illustrated the differences between age groups. The findings from the Poisson and the Negative Binomial Regressions did not show any association between the independent variables and the dependent variable. The results of these statistical analyses were influenced by the discrepancies that caused a change in the sample size and gave rise to recommendations for future research. Plus, the results of the analyses indicated what could be the implications of the outcome of this study. Finally, I can draw a conclusion that was based on the findings of this study.

In closing, I presented the results of the statistical analyses as they related to each research question. For the question of gender and its association with tuberculosis incidence, the trends were limited to two age groups but with no direction. Place of birth and tuberculosis incidence pointed their trends toward older age groups along with no direction. With substance abuse and tuberculosis incidence, there was a social dynamic that demonstrated that age had social and clinically aspects along with trends for middle age groups with no direction. For residence and tuberculosis incidence, the trends split with young age groups having significant and older age groups not having significant, yet no direction. The results of the research questions and the nature of the data that were collected became the conduit to the interpretations of each research question that is found in Chapter 5.

Chapter 5: Discussion

Introduction

The main purpose of this research was to examine whether there is a change in the influence of social determinants on tuberculosis incidence at the state level. The tuberculosis incidence cases covered noninstitutionalized patients from 1995 to 2012 for the state of New Jersey. I found that different social determinants have an influence on different community levels (e.g. local, national, global; Barr et al., 2001; Centers for Disease Control and Prevention, 2011; Dye et al., 2009; Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007). The results are presented to describe the influence of various social determinants on tuberculosis incidence at the state level. The key findings of this study were based on the individual research questions as well as the collectiveness of the research questions. Age had an effect on tuberculosis incidence trends, while other factors had little impact on tuberculosis rates. Data collection procedures may have impacted the findings and will be discussed in this chapter as well.

According to the results of the study, the responses to the research questions were mixed. With regard to the association between gender and tuberculosis incidence trend, I confirmed that there were no association between gender and tuberculosis incidence trend. For the association between place of birth and tuberculosis incidence trend, I found that there was some association between place of birth and tuberculosis incidence trend. With the association between substance abuse and tuberculosis incidence trend, I found no confirmation of the association between substance abuse and tuberculosis incidence trend for the different age groups. The results for the association between residence and tuberculosis incidence trend were not similar to what is in the literature. Also, the age of the patient was an influencer of the social determinants and tuberculosis incidence trend.

Interpretation of Findings

The statistical tests used in this study were the Mantel-Haenszel extension of the chi-square test for trend, Poisson Regression, and Negative Binomial Regression. The Mantel-Haenszel extension of the chi square test for trend function was applied to detect trends by a series of odds ratios with a chi-square formula to determine level of significance. Trends were evaluated by a computing a series of odds ratios values over time and examining whether these were increasing or decreasing. Also, the length of interval of increases or decreases in the odds ratios was used to evaluate the strength of the trend association. For instance, a 7-year trend would be stronger than a 3-year trend. The Poisson Regression and the Negative Binomial Regression were used to determine whether there was an association between a social determinant and tuberculosis incidence over a time frame. Both the Poisson Regression and the Negative Binomial Regression were employed to analyze count data. The only difference between the two is that the Negative Binomial Regression can handle overdispersal in which the variance is greater than the mean. Both regressions were used because there is no procedure that can confirm overdispersion in this study.

The aim of each research question was to determine the epidemiological triad present at the state level. Because relevant research is limited for dealing with the research questions, the theoretical base of the epidemiological triad became the best reference for dealing with the host and environment interaction. For gender, the theory aspect dealt with a characteristic of the host being. With place of birth, the environment of the host's origin was the source of the analysis. With regards to substance abuse, internal conditions of the host interacting with external conditions of the environment, whether physical or social, were the core consideration. For residence, the effects of social and physical environments were the focus of that question. Because of the stratification of the demographic age, the interpretation of each research question with each age group was done.

The research questions were selected to determine whether the social determinants that were available had an impact on the tuberculosis incidence trend. The statistical analysis was conducted under 11 conditions. These conditions were based on the Mantel-Haenszel extension of the chi square test for trend with six age groups plus the comprehensive analysis, the Poisson Regression with two runs, and the Negative Binomial Regressions with two runs. Failure to reject or rejecting the null hypothesis for each research question for each condition determined whether the given social determinant had some impact on tuberculosis incidence trends. The number of failure to reject or rejection of the null was the indicator of whether that social determinant had any impact.

Association between Gender and Tuberculosis Incidence Trend

The findings for gender and tuberculosis incidence trend were consistent with the results of previous studies that did not show an association between gender and tuberculosis incidence (Craig et al., 2007; Dye et al., 2009; Hargreaves et al., 2011; Jung et al., 2010; Oren et al., 2011). Furthermore, the results for this study were similar to other research despite differences in the statistical procedures that were used, the study samples, and the uniqueness of study designs (Craig et al., 2007; Dye et al., 2009; Hargreaves et al., 2011; Jung et al., 2010; Oren et al., 2011). For gender, adulthood was the social determinant that has impacted tuberculosis incidence trend, but not elderly adulthood. There were age groups along with the comprehensive analysis that the Mantel-Haenszel extension of the chi-square test for trend values were computed to be significant and that the results had trends.

I confirmed that there was no trend with the association between the tuberculosis incidence trend and gender. The findings of the Mantel-Haenszel extension of the chi square test for trend indicated that a boy between the ages of 0 (less than 12 months) and 4 years has no more influence than a girl between the same age range on tuberculosis incidence trend. Because there was no citation for this age group, this group is infected by others of the different age groups due to irregular counts. The findings for this age group stratum had no influence on other strata.

For the 5 to 14 years age group, I found no trend between gender and tuberculosis incidence. The odds ratios pattern did confirm that there was no trend for the 5 to 14 years age group, which was not consistent in the literature (Craig et al., 2007; Dye et al., 2009; Hargreaves et al., 2011; Jung et al., 2010; Oren et al., 2011). There was no factor or influencer between the genders and tuberculosis incidence. Because there was no previous research on the 5 to 14 years age group, the infection of this age group by tuberculosis was coming from other sources, possible other age groups. For this age group stratum, there was no influence beyond this stratum.

With the 15 to 24 years age group, there was no trend between gender and tuberculosis incidence. Neither gender of this age group was an influencer of the tuberculosis incidence trend. In the odds ratios pattern, this age group did not have a trend. Because this age group was composed of children and adults, the findings for this age group lent toward what have been cited in the literature for adult patients. The 15 to 24 years age group stratum was not an effecter of other groups' strata.

For the age group of 25 to 44 years, I found that there was an association between gender and tuberculosis incidence trend, an observation that differs from the literature (Craig et al., 2007; Dye et al., 2009; Hargreaves et al., 2011; Jung et al., 2010; Oren et al., 2011). The observed trend was a series of patterns and not a continuous trend and the patterns were short in duration and weak in magnitude. I described this pattern as an non-steady state. The calculated significance was caused by the number of counts for this age group. I did not confirm which gender has been the influencer of tuberculosis incidence trend because the pattern swung from one gender side to the other gender side. This age group might have had an effect on other age groups because of large number of counts that existed for each year.

For the 45 to 64 years age group, I did not confirm that the association between gender and tuberculosis incidence trend produced a trend for this age group as in the literature. I confirmed that neither gender influenced the tuberculosis incidence trend for this age group because the odds ratios pattern oscillated between the two categories. For the 45 to 64 years age group, I considered that the group was not an influencer for other age groups with regards to tuberculosis incidence trend.

For the 65 years and over age group, I did not confirm that the association between gender and tuberculosis incidence trend generated a trend among this age group. For this age group, I did not confirm what gender had influence on the tuberculosis incidence trend as in the literature. The results for the 65 years and over age group were confined to this age group.

The comprehensive analysis for the research question that dealt with the association of gender and tuberculosis incidence trend had significance to confirm the presence of a trend. These results were counter to what was in the literature. The observed findings of the odds ratios pattern did not confirm the trend because the odds ratios pattern changed direction with each year of the study and nothing being steady. The odds ratios pattern was constantly switching from increasing values to decreasing values and back again. The significance of this comprehensive analysis was probably due to the results of the 25 to 44 years age group because of its size (3824 cases, 40.2%). While the comprehensive analysis dealt with the total counts for each cell of the matrix, the majority of the counts for each cell belonged to the 25 to 44 years age group. The observed odds ratios pattern lent toward males as being the influencer of the tuberculosis incidence, which could be a phenomenon of the gender ratio in this study (5502/4016; male/female) because the majority usually carry the influence.

For the association of gender and tuberculosis incidence trend, the Poisson and the Negative Binomial Regressions were used. I found no linear association because of a slope of zero for the Poisson Regression and the Negative Binomial Regression. Also, the findings showed that the intercept did vary for both regressions. The findings did confirm that neither male nor female were dominant in both regressions (Frieden et al., 2003; Lawn & Zumla, 2011; Maartens & Wilkinson, 2007; Snider, 2001). In addition, age of the patient was included as a covariate because previous studies have shown that age of the patient is a factor in analyzing diseases (Ahmad, 2012; Myers et al., 2006). The findings produced no association for the covariate age and no interaction between age and time. Thus, there was no linear association between gender and tuberculosis incidence trend, which was similar to the literature.

The association between gender and tuberculosis incidence trend was limited based on which statistical analysis method was viewed. The null hypothesis failed to be rejected for all conditions except two of them. Gender as a social determinant did not have a strong influence on tuberculosis incidence trend. It made no difference whether the infected host was male or female, only the age of the host had an effect. While the null hypothesis failed to be rejected for most of the conditions related to the association between gender and tuberculosis incidence trend, the results did follow what was found in the literature (Craig et al., 2007; Dye et al., 2009; Hargreaves et al., 2011; Jung et al., 2010; Oren et al., 2011).

Association between Place of Birth and Tuberculosis Incidence Trend

The findings for the association between place of birth and tuberculosis incidence trend showed that there could be at least two situations present. The findings indicated that there was an association between place of birth and tuberculosis incidence trend but the confirmation could be limited along with the fact that is no debate about place of birth not being a factor in the literature, which was one situation. The other situation dealt with age of the patient in that exposure to the place of birth environment could be underscored due to age (Bloss et al., 2011; Thompson et al., 2002). At younger ages, there might not be any influence by place of birth as compared to older ages. With place of birth, youth was not an influence on tuberculosis incidence trend, nor was the environment of place of birth a factor on younger hosts. My study showed the interaction of environment of place of birth and the host's age. To see these situations, an examination of each age group was performed.

For the 0 to 4 years age group, I could not confirm the trend with association between place of birth and tuberculosis incidence trend. The findings showed no trend with regards to the odds ratios pattern. With no previously citations, I classified place of birth for this age group as a non-factor because of a limited exposure to those environments. This age group showed the situation of the interaction of host's age and environment.

For the age group of 5 to 14 years, I found a confirming trend for the association between place of birth and tuberculosis incidence trend. The results of the odds ratios pattern showed no trend and did not point to either category of place of birth (U.S.-born versus foreign-born). For this age group, I saw the effect of age and the place of birth environment.

With the age group of 15 to 24 years, the findings did confirm a trend for the association between place of birth and tuberculosis incidence trend. The results for this age group did not show an observable pattern between the categories of place of birth with regards to the odds ratios. This was another age group that showed that the host's age and the place of birth environment did have a weak interaction.

For the age group of 25 to 44 years, I found a trend for the association between place of birth and tuberculosis incidence trend. The results of the odd ratios pattern showed a short trend that was made of 3 to 4 years. These short patterns were an indicator that place of birth did provide some impact on tuberculosis incidence trend for this age group. The findings indicated that foreign born patients as being the influencer of the association between place of birth and tuberculosis incidence trend. For this age group, exposure to the environment of place of birth was a factor. The age group of 25 to 44 years was an indication that place of birth and tuberculosis incidence trend became an interaction of environment and host.

With the 45 to 64 years age group, the findings did confirm a trend for the association between place of birth and tuberculosis incidence trend. For this age group, the results of the odds ratios trend showed that the pattern was a weak declining type of trend. The findings for this age group lent toward foreign born as the influencer of the trend. The 45 to 64 years age group became another age group that showed that place of birth environment and tuberculosis incidence trend have an interaction with the host's age as a factor.

The findings for the age group of 65 years and over did confirm a trend for the association between place of birth and tuberculosis incidence trend. The results of the odds ratios pattern showed a weak decreasing trend. The findings for this age group pointed to foreign born patients as the influencer of the trend. This age group became an additional age group that showed that host's age was a factor in the interaction of place of birth's environment and tuberculosis incidence trend.

For the comprehensive analysis for the association between place of birth and tuberculosis incidence trend, the findings did confirm that there was a trend for the overall study. The results of the odds ratios pattern showed a trend that pointed to foreign born patients as the influencing factor in this trend study. The findings for the association between place of birth and tuberculosis incidence trend might have more than one consideration and that place of birth environment and the host's age had some interaction.

The findings of the Poisson Regression and the Negative Binomial Regression for the association between place of birth and tuberculosis incidence trend showed what the model for each regression should appear to be. The findings indicated that there were no association between place of birth and tuberculosis incidence trend and no influence from the categories of place of birth (U.S.-born and foreign-born) and age of patient; whether as a covariate or interaction. According to the findings, these statistical methodologies showed that place of birth environment had no impact on tuberculosis incidence trend.

The null hypothesis for the association between place of birth and tuberculosis incidence trend was rejected for 5 out of 11 analyses. Adulthood made the social determinant, place of birth, to be an influencing factor on tuberculosis incidence trend, but overall place of birth did not have dominant on tuberculosis incidence trend. Place of birth indicated that the patient's age was a factor in determining the impact on tuberculosis incidence trend. The null hypotheses that were related to place of birth showed that there were limitations.

Association between Substance Abuse and Tuberculosis Incidence Trend

The findings for the research question that dealt with the association of substance abuse and tuberculosis incidence trend did not fully confirm what had been found previously (Boccia et al., 2011; Craig et al., 2007; Lin et al., 2007; Lin et al., 2008; Rehm et al., 2009). Substance abuse was defined as a source that causes the body's immune system to decrease, thereby preventing the person from fighting off an infection. Under certain circumstances, the patient's age could determine whether substance abuse was a determinant or not. When it comes to substance abuse and tuberculosis, researchers have showed or discussed what are the effects and interactions on the adult populations, which have been an increase in the incidence rates for the abusers (Andre et al., 2007; Barr et al., 2001; Bloss et al., 2011; France et al., 2007; Hargreaves et al., 2011; Lin et al., 2008; Maartens & Wilkinson, 2007; Wylie et al., 2007). According to my study, there were indications that at different ages the determinant, substance abuse, can or cannot be used as a determinant. In the youngest age group, I found no substance abusers. For substance abuse, the literature to the best of my knowledge has not presented results that connected children behavior, being substance abusers, with tuberculosis incidence. Substance abuse could not be established as a determinant in the association between substance abuse and tuberculosis incidence trend because of some of the age groups.

For the 0 to 4 years age group with regards to the association between substance abuse and tuberculosis incidence trend, no calculations were done. The reason for no calculations being done was because there were no patients in this age group who were classified as abusers. This was a circumstance in which the host' age became a factor in deciding whether a social determinant can be seen as a social determinant or not.

The 5 to 14 years age group produced findings that did not confirm a trend for the association between substance abuse and tuberculosis incidence trend. The resulting odds ratios pattern for this age group showed no true trend. This age group of 5 to 14 years also indicated that substance abuse in the presence of tuberculosis could have an age dependent factor because of a near zero patient count for substance abusers. Again, the host's age was a factor for whether a social determinant was a social determinant or not.

For the 15 to 24 years age group, I could not confirm that a trend existed for the association between substance abuse and tuberculosis incidence trend. The resulting odds ratios pattern showed no trend for this age group. For this age group also, there was no indication that the host's age was a factor. The counts for the abusers were irregular, which gave the possibility that substance abuse was not a strong social determinant for this age group.

The findings for the age group of 25 to 44 years did confirm that a trend existed for the association between substance abuse and tuberculosis incidence trend. What I observed that the odds ratios pattern showed that the trend was decreasing and substance abuse was not a driving factor in maintaining the trend. The decreasing trend could indicate that substance abuse and/or the infect rates were declining. For the association between substance abuse and tuberculosis incidence trend, the non-abusers was the group that influenced the trend.

The age group of 45 to 64 years had findings that did confirm a trend for the association between substance abuse and tuberculosis incidence trend. What I observed of the odds ratios pattern for this age group showed a weak trend that did not point toward either abusers or non-abusers as an influencer. This trend oscillated between the two categories. Because the trend moved between the two categories, the social determinant may not have a strong impact on tuberculosis incidence trend.

The 65 years and over age group had findings that did not confirm a trend for the association between substance abuse and tuberculosis incidence trend. What I saw about the odds ratios was that any pattern did not exist as the pattern and did not appear to be stable nor steady. For this age group, substance abuse was not an influencer of the tuberculosis incidence trend. Thus, the host's conditions did not impact tuberculosis incidence trend or the external conditions of the environment affected the host's conditions.

The comprehensive analysis for the association between substance abuse and tuberculosis incidence trend showed findings that did confirm a trend. The observed odds ratios pattern did confirm a trend, but not a steady one for the complete study period. There were some decreases and increases in the pattern. The trend pointed toward the non-abusers as the source for the influence. The comprehensive analysis showed that substance abuse as a social determinant could have been an influencer on tuberculosis incidence trend.

The association between substance abuse and tuberculosis incidence trend had findings that produced no direction. With the association, there was no linear association and no interaction between the independent covariates. The findings were based on the results of using the Poisson Regression and the Negative Binomial Regression. The regression results did not give any direction or support for any interaction. The regression results did not show that non-abusers had influence over abusers (user of drugs). This was proof that substance abuse in New Jersey was not a social determinant for tuberculosis incidence trend. Finally, the findings did not provide any model to be used as a guide for future studies.

Substance abuse as a social determinant made the null hypothesis to become a question of existence. The null hypothesis was rejected three times, accepted seven times, and once could not be answered. Substance abuse did not have a broad acceptance as a social determinant for tuberculosis incidence trend because of the host's age. With substance abuse, the host's condition and the environment circumstance did not have influence on tuberculosis incidence trend. The association between substance abuse and tuberculosis incidence trend pointed to the host in the environment, whereas residence looked at the environment that surrounded the host with regards to the agent.

Association between Residence and Tuberculosis Incidence Trend

The findings related to the association of residence and tuberculosis incidence trend did indicate some confirmation based on age. For cases of patients younger than 45 years of age, the findings showed that there was an association between residence and tuberculosis incidence trend (Kim et al., 2003; Myers et al., 2006; Ompad et al., 2007;

Wylie, Shah, & Jolly, 2007). Patients who were 45 years and above showed no association with residence and tuberculosis incidence trend. This situation confirmed that the environment that the cases of patients younger than 45 years occurred could have had an impact on the tuberculosis incidence trend. There was no indication of the type of residence that had an impact on the tuberculosis incidence trend. In the literature, residence was classified as part of the socioeconomic status but in this study it was not because of the manner in which residence was described (Baumann et al., 2007; Burton et al., 2010; Craig et al., 2007; Jung et al., 2010).

For the age group of 0 to 4 years, I did calculated a value that was significant for a trend for the association between residence and tuberculosis incidence trend. However, the odds ratios pattern did not confirm a trend due to the fact that some of the years in the study had counts of zero for one of the categories and the mathematical value of infinite has no part in a trend. The trend was not supported by either category "Low" (medium housing price below the pre-study calculated average medium housing price) or "High" (medium housing price above the pre-study calculated average medium housing price). For this age group, the type of residential environment was not a effecter on tuberculosis incidence trend. With this age group, the confirmation was due to calculate results, not odds ratio patterns.

For the 5 to 14 years age group, the findings did confirm a trend for the association between residence and tuberculosis incidence trend. The trend results were based on the calculated chi-square formula. What I observed of the odds ratios pattern did not reveal any form of trend for this age group with regards to the association between residence and tuberculosis incidence trend. The odds ratios pattern had many changes of direction and could not be considered a trend. There was no influencer from either of the two categories for this age group. The paradox between the calculated significance and observed odds ratios indicated that residential environment and the tuberculosis incidence tend had no true association.

The 15 to 24 years age group had findings that did confirm that a trend existed for association between residence and tuberculosis incidence trend. What I saw of the resulting odds ratios pattern did not indicate that a trend existed for the 15 to 24 years age group. The influencing factor seemed to be mixed within both categories, "High" and "Low". For this age group, the residential environment had no visible effect on the number of tuberculosis cases.

For the 25 to 44 years age group, I confirmed a trend for the association between residence and tuberculosis incidence trend. The resulting odds ratios pattern did not reinforce the concept of having a trend for this age group. The odds ratios pattern produced an illustration of fluctuating influences between the categories of "Low" (medium housing price below the pre-study calculated average medium housing price) and "High" (medium housing price above the pre-study calculated average medium housing price) for this age group. The pattern was not stable and the direction was not certain. With the 25 to 44years age group, there might have been some influence on the tuberculosis incidence trend by the residential environment.

For the 45 to 64 years age group, I did not confirm a trend for the association between residence and tuberculosis incidence trend. The observed odds ratios pattern did confirm that there was no trend that existed for this age group. None of the categories for this age group indicated as to being an influencing factor for this research question. For this age group, the residential environment was not a factor with tuberculosis incidence trend.

With the 65 years and over age group, I found no trend for the association between residence and tuberculosis incidence trend. Also, the odds ratios pattern result did not indicate that there was a trend for this age group. Each of the categories for the 65 years and over age group showed no dominant group that could have influenced a trend situation. With this age group, the residential environment had no association with tuberculosis incidence trend.

The comprehensive analysis findings did confirm the existence of a trend for the association between residence and tuberculosis incidence trend. What I observed of the odds ratios pattern did not show a notable trend. While the other comprehensive analyses patterns were decreasing, the comprehensive analysis trend for the association between residence and tuberculosis incidence trend was increasing. Each of the categories did not express influence over the study period. With the comprehensive analysis, the residential environment seemed to have an association with tuberculosis incidence trend.

The Poisson Regression and the Negative Binomial Regression for the association between residence and tuberculosis incidence trend did not produce findings that could be used in modeling building. The regressions results generated parameters of zero that might not be used in modeling building. I did not found any supporting information on the direction with just the independent variable or with the covariates along with any interaction. Neither the Poisson Regression nor the Negative Binomial Regression had findings that indicated that the independent categories, "Low" (medium housing price below the pre-study calculated average medium housing price) and "High" (medium housing price above the pre-study calculated average medium housing price), had the stronger influence on tuberculosis incidence trend. The regressions showed that there was no association between the residential environment of the host and tuberculosis incidence over time.

The research question for the association between residence and tuberculosis incidence trend made the null hypothesis to set for rejecting with over half of the conditions for one statistical method and failure to reject for the others. For the trend analyses, the null was rejected for five analyses for age groups being for under 45 years of age. In that view, the social determinant residence showed its influence on mostly young hosts. There was no dominant seen for this social determinant. For those hosts under 45 years of age, the physical and social environments had influence on tuberculosis incidence trend. Though it seemed that the host's residential environment had association with tuberculosis incidence trend, but that was conditional based on the host's age.

Limitations of the Study

The limitation of this study arose from the fact that the data came from a secondary source. The data that were used in this study came from the database of the New Jersey Department of Health Tuberculosis Program that covered a period of 20 years. The Tuberculosis Program was the collector and keeper of the data that were used. The Tuberculosis Program established the criterions and categories in which the data were collected. I did not participate in the actual data collecting at any time. The type of data source dictated whether the interpretation can be generalized or trustworthy. The fact with this data source was that there has been a discrepancy in the treatment of the data, mainly the loss of cases that were not corrected for 1993 and 1994. For the years 1993 and 1994, there were cases that had data elements omitted. The missing information that covered substance abuse status and place of birth were found to exist. It seemed that missing information was the reason why the number of cases were reduced for 1993 and 1994. It was known how many cases existed for those years from a previous published source from the Tuberculosis Program. The source was a chart that had the distribution of cases per county from 1993 to 2009 plus the total tuberculosis incidence cases for each year. Because of this chart, I considered that the data that I received for 1993 and 1994 had errors. The chart showed residence but not substance abuse status, place of birth, nor gender. I requested data that covered gender, substance abuse status, place of birth, residence, and year of detection for each case between the years of 1993 to 2012. I did inquire about the missing data but received no response. I also sent a copy of the chart or the file to the person who I was communicating with to clarify what the situation was but still no response to what was occurring. The use of those cases could result in bias or erroneous interpretations. Thus, generalizability and trustworthiness were hindered and the limitation remained the same. Therefore, any revisions of the limitations could be insignificant.

As for the statistical tests that were used in this study, the limitations are based on whether any of the statistical assumptions were violated. With the Poisson and the

Negative Binomial Regressions, the assumption that would affect the limitation is the dispersion. The dispersion for Poisson Regression is that the variance is equal to the mean and for Negative Binomial Regression is that the variance is greater than the mean (McNamee, 2005; Piza, 2012). Because there is no procedure to determine what the dispersion is in this study, both the Poisson and the Negative Binomial Regressions are used. As for the Mantel-Haenszel extension of the chi-square test for trend, the limitation is based on the violation of any of its statistical assumptions (Pett,1997; See Chapter 4, page 46 for lists of assumptions). To deal with the limitations, there can be recommendations to change certain situations.

Recommendations

I recommend that future research be conducted using a broader pool of socio-demographic variables (e.g., living accommodations) to provide a better understanding of what other factors have an impact on tuberculosis incidence trend. These variables would represent factors related to the host's environment and to the host being. Also, I recommend that a qualitative survey be made each year to monitor which demographics are present. The qualitative survey would serve two purposes. In the process of doing a network follow-up after the identification of an infected person, the survey is used primarily to collect demographic and clinical data on the patient as the first purpose. The second purpose would be to aid in understanding the type of social network that would be involved. For instance, if the patient is homeless, then investigating homeless shelters for contact information would be among the next steps. The survey then would become the information collection source. For the next uninfected person or/and infected person in the network, the information would confirm the loci information (first person or source of the infection). The type information on the survey would be tested through pilot studies in order to have data for the infection network and for additional trend studies. After the survey is ready, a tuberculosis incidence trend study should be done every 10 years to monitor for changes in the demographics and the relationship between the demographics and tuberculosis incidence on the state level. The tuberculosis incidence trend studies should be a mixed study with a quantitative and a qualitative portion. Each portion would give data that could be exchanged to give a broader informational base.

Implications

The implications of this study would indicate how to control tuberculosis infections through the social aspect of the disease. Different social aspects could determine the type of procedure or treatment to be used, like treating young children who might have tuberculosis versus an adult who is a substance abuser with tuberculosis. Knowing the social environment of the patient could give insight to what steps to use to treat the patient and prevent the spread of tuberculosis to others. Also, the social environment would point out which social roles could be present and possibly the type of social network that could exist for different age groups.

One consistently observed finding across research studies is that the patient's age influences the tuberculosis infection by way of social demographics. The patient's age can become the source of knowing about the locus of support and transmission networks. Knowing the patient's age establishes the foundation for supporting treatment in that the "who is part of the patient's life" and "who can be used to help". Awareness of the patient's ages gives guidance to what was the source of the infection and who could be next to be infected. The following narratives could illustrate the concepts that have been generated from the statistical analyses that were done in this study.

The age of the patient sets the stage for how the patient was infected and who would be there to help. For a young patient who is under 15 years of age, the infection source would likely be an older acquaintance, but a family member would likely be the source of the directly observed treatment. Between 15 and 25 years of age, the patient would probably be infected by an older acquaintance or someone of the same age group, and a family member or an acquaintance would be the source of support for treatment. With a patient between the ages of 25 to 45 years, the infection source could be a family member or a casual acquaintance, but the directly observed treatment support could be a family member or a professional healthcare provider. Patients who are between the ages of 45 and 65 years could be infected by anyone who is slightly younger, in the same age range, or in the family; but as for support for treatment the source could be a family member or a professional healthcare provider. For any patient who is over 65 years of age, the source of infection could be anyone who is a family member, a casual acquaintance, or the reactivation of a latent infection that was untreated. However, the treatment support would be a professional healthcare provider or volunteer. These narratives are just to illustrate some of the applications of the information that has been generated by this study. The narratives are to show what the implications are when viewing the findings as a collective of information.

Conclusion

In conclusion, the impact of social determinants on tuberculosis incidence trend at the state level is based on age and which social demographics are being examined. Social determinants or demographics as the only components do not have an impact on tuberculosis incidence trend. Age of patient or age group alone cannot influence tuberculosis incidence trend at the state level. A combination of age of the patient and the array of social determinants could establish whether an impact could occur on tuberculosis incidence trend. How that array of social determinants is set could be considered as being unknown at this time. The length of the trend would not be long in duration at times but could exist. The demographic *age* can limit which social determinant can aid in showing the degree of impact on the tuberculosis incidence trend. The social change implications for this project are that identifying the factors that impact tuberculosis incidence might reduce and lead to more targeted interventions, which in turn, might help to reduce the burdens that are associated with this disease.

References

Ahmad, S. (2011) Pathogenesis, immunology, and diagnosis of latent Mycobacterium tuberculosis infection. *Clinical and Developmental Immunology 2011*, doi:10.1155/2011/814943.

Alani, A., Barton, I.E., Seymour, M.J., & Wrobel, L.C. (2001). Application of Lagrangian particle transport model to tuberculosis (TB) bacteria UV dosing in a Ventilated isolation room. *International Journal of Environmental Health Research, 11*, 219-228. doi:10.1080/09603120047000.

Andre, M., Ijaz, K., Tillinghast, J. D., Krebs, V. E., Diem, L. A., Metchock, B.,...McElroy, P. D. (2007). Transmission network analysis to complement routine tuberculosis contact investigations. *American Journal of Public Health, 97*(3), 470-477. Retrieved from http://www.apha.org/publications/journal

Atkins, D. C. & Gallop, R. J. (2007). Rethinking how family researchers model infrequent outcomes: A tutorial on count regression and zero-inflated models. *Journal of Family Psychology, 21*(4), 726-735. doi:10.1037/0893-3200.21.4.726.

Barr, R. G., Diez-Roux, A. V., Knirsch, C. A., & Pablos-Mendez, A. (2001). Neighborhood poverty and the resurgence of tuberculosis in New York City, 1984-1992. *American Journal of Public Health, 91* (9), 1487-1493. Retrieved from http://www.apha.org/publications/journal

Barros, A. J. D. & Hirakata, V. N. (2003). Alternatives for logistic regression in cross-sectional studies: An empirical comparison of models that directly estimate the prevalence ratio. *BioMed Central Medical Research Methodology, 3*(21). Retrieved from http://www.biomedcentral.com/1471-2288/3/21

Baumann, M. H., Nolan, R., Petrini, M., Lee, Y. C. G., Light, R. W., & Schneider, E. (2007). Pleural tuberculosis in the United States. *Chest, 131*, 1125-1132, doi:10.1378/chest.06-2352.

Binary outcome, test for trend (n.d.). Retrieved from http://www.sjsu.edu/faculty/gerstman/EpiInfo/bin-trend.htm

Bloss, E., Holtz, T. H., Jereb, J., Redd, J.T., Podewils, L. J., Cheek, J. E.,…McCray, E. (2011). Tuberculosis in indigenous peoples in the U.S. 2003-2008. *Public Health Reports, 126*. Retrieved from http://www.publichealthreports.org

Boccia, D., Hargreaves, J., De Stavola, B. L., Fielding, K., Schaap, A., Godfrey-Faussett, P.,…Ayles, H. (2011). The association between household socioeconomic position and prevalent tuberculosis in Zambia: a case-control study. *PLOS One, 6* (6), doi: 10.1371/journal.pone.0020824.

Burton, D. C., Flannery, B., Bennett, N. M., Farley, M. M., Gershman, K., Harrison, L. H.,…Schuchat, A. (2010). Socioeconomic and racial/ethnic disparities in the incidence of bacteremic pneumonia among U.S. adults. *American Journal of Public Health, 100* (10), 1904-1911. doi: 10.2105/AJPH.2009.

Centers for Disease Control and Prevention. (2006). Trends in tuberculosis – United States, 2005. *Morbidity and Mortality Weekly Report, 55,* 305-308. Retrieved from http://www.cdc.gov/mmwr/

Centers for Disease Control and Prevention. (2008, February 1). Workplace-based investigation of contacts of a patient with highly infectious tuberculosis-Maryland, District of Columbia, and Virginia, 2006. [Electronic version]. *Morbidity and Mortality Weekly Report, 57*(4), 94-98. Retrieved from http://www.cdc.gov/mmwr/

Centers for Disease Control and Prevention. (2009). Reported tuberculosis in the United States, 2008. Retrieved from http://www.cdc.gov/tb/

Centers for Disease Control and Prevention. (2010). New Jersey 2010 profile. Retrieved from http://www.cdc.gov

Centers for Disease Control and Prevention. (2011). Prevalence and trends data. Retrieved from http://www.cdc.gov

Centers for Disease Control and Prevention. (2011). Trends in tuberculosis – United States, 2010. *Morbidity and Mortality Weekly Report, 60,* 333-337. Retrieved from http://www.cdc.gov/mmwr/

Chan, J. Y. C., Tian, L., Kwan, Y. W., Chan, W. M., & Leung, C. W. (2011). Hospitalizations for varicella in children and adolescents in a referral hospital in Hong Kong, 2004 to 2008: A time series study. *BioMed Central Public Health, 11*, 366. Retrieved from http://www.biomedcentral.com/1471-2458/11/366.

Cole, S. T., Brosch, R., Parkhill, J., Garnier, J., Churcher, C., Harris, D., Gordon, S. V.,…Barrell, B. G. (1998). Deciphering the biology of *Mycobacterium tuberculosis* from the complete genome sequence. *Nature, 396*, 537-544.

Comas, I., & Gagneux, S. (2009). The past and future of tuberculosis research. *PLOS*

Pathogens, 5 (10) e1000600. doi:10.1371/jounrnal.ppat.1000600.

Coxe, S., West, S. G., Aiken, L. S. (2009). The analysis of count data: A gentle introduction to Poisson regression and its alternatives. *Journal of Personality Assessment, 91(2),* 121-136. doi: 10.1080/00223890802634175.

Craig, G. M., Booth, H., Story, A., Hayward, A., Hall, J., & Zumla, A. (2007). The impact of social factors on tuberculosis management. *Journal of Advanced Nursing, 58*(5), 418-424.doi: 10.1111/j.1365-2648.2007.04257.x.

Davidow, A. L., Mangura, B. T., Napolitano, E. C., & Reichman, L. B. (2003). Rethinking the socioeconomics and geography of tubculosis among foreign-born residents of New Jersey, 1994-1999. *American Journal of Public Health, 93* (6), 1007-1012. Retrieved from http://www.apha.org/publications/journal

Dye, C., Lonnroth, K., Jaramillo, E., Williams, B. G., & Raviglione, M. (2009). Trends in tuberculosis incidence and their determinants in 134 countries. *Bulletin of the World Health Organization, 87*, 683-691. doi:10.247/BLT.08.058453.

Ettner, S. L. & Grzywacz, J. G. (2001). Workers' perceptions of how jobs affect health: A social ecological perspective. *Journal of Occupational Health Psychology, 6* (2), 101-113. doi: 10.1037//1076-8998.6.2.101.

Field, A. (2009). *Discovering Statistics Using SPSS* (3rd ed.). Los Angeles, CA: Sage.

France, A. M., Cave, M. D., Bates, J. H., Foxman, B., Chu, T., & Yang, Z. (2007). What's driving the decline in tuberculosis in Arkansas? A molecular epidemiologic analysis of tuberculosis trends in a rural, low-incidence population, 1997-2003. *American Journal of Epidemiology, 166*, 667-671. doi: 10.1093/aje/kwn135.

Frieden, T.R., Sterling, T.R., Munsiff, S.S., Watt, C.J., & Dye, C. (2003). Tuberculosis. *The Lancet, 362*, 887-899. Retrieved from http://www.thelancet.com/

Friis, R.H, & Sellers, T.A. (2004). *Epidemiology for public health practice,* (3rd ed.). Sudbury, MD: Jones and Bartlett

Gagnon, D. R., Doron-LaMarca, S., Bell, M., O'Farrell, T. J., & Taft, C. T. (2008). Poisson regression for modeling count and frequency outcomes in trauma research. *Journal of Traumatic Stress, 21*(5), 448-454. doi: 10.1002/jts.20359.

Grzywacz, J. G. & Fuqua, J. (2000). The social ecology of health: Leverage points and linkages. *Behavioral Medicine, 26*(3), 101-115. Retrieved from http://www.tandf.co.uk/journal/titles/08964289.asp

Hargreaves, J. R., Boccia, D., Evans, C. A., Adato, M., Petticrew, M., & Porter J. D. H. (2011). The social determinants of tuberculosis: From evidence to action. *American Journal of Public Health, 101*(4), 656-662. doi:10.2105/AJPH.2010.199505.

Hartley, S. (2012). The BMI Formula. Retrieved from http://www.whathealth.com/bmi/formula.html

Higuchi, K., Kawabe, Y., Mitarai, S., Yoshiyama, T., Harada, N., & Mori, T. (2009). Comparison of performance in two diagnostic methods for tuberculosis infection. *Medical Microbiology and Immunology, 198*(1) 33-37. doi:10.1007/s00430-008-0102-5.

International Business Machines (2011). Mantel-Haenszel test for trend available in crosstabs. Retrieved from http://www-01.ibm.com/support/docview.wss

Jacobsen, S. J., Freedman, D. S., Hoffmann, R. G., Gruchow, H. W., Anderson, A. J., & Barboriak, J. J. (1992).Cholesterol and coronary artery disease: age as an effect modifier. *Journal of Clinical Epidemiology, 45*(10), 1053-1059. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/1474401

Jung, R. S., Bennion, J. R., Sorvillo, F., & Bellomy, A. (2010). Trends in tuberculosis mortality in the United States, 1990-2006: a population-based case-control study. *Public Health Reports, 125*, 389-397. Retrieved from http://www.publichealthreports.org

Jung, S. H., Chow, S. C., & Chi, E. M. (2007). A note on sample size caculation based on propensity analysis in nonrandomized trials. *Journal of Biopharmaceutical Statistics, 17*, 35-41. doi:10.1080/10543400601044790.

Karlsson, E. A. & Beck, M. A. (2010). The burden of obesity on infectious disease. *Experimental Biology and Medicine, 235*, 1412-1424. doi: 10.1258/ebm.2010.010227.

Kim, S. & Crittenden, K. S. (2005). Risk factors for tuberculosis among inmates: A retrospective analysis. *Public Health Nursing, 22*(2), 108-118. Retrieved from http://www.wiley.com/WileyCDA/WileyTitle/productCd-PHN.html

Kloos, B. & Shah, S. (2009). A social ecological approach to investigating relationships between housing and adaptive functioning for persons with serious mental illness. *American Journal of Community Psychology, 44*,316-326. doi: 10.1007/s10464-009-9277-1.

Knechel, N. A. (2009). Tuberculosis: Pathophysiology, clinical features, and diagnosis. *Critical Care Nurse, 29*(2), 34-44. doi: 10.4037/ccn2009968.

Korbel, D. S., Schneider, B. E., & Schaible, U. E. (2008). Innate immunity in tuberculosis: Myths and truth. *Microbes and Infection, 10*, 995-1004. doi: 10.1016/j.micinf.2008.07.039.

Lalvani, A. (2007). Diagnosing tuberculosis infection in the 21st century: New tools to tackle an old enemy. *Chest, 131* 1898-1906. doi: 10.1378/chest.06-2471.

Lashley, M. (2006). A targeted testing program for tuberculosis control and prevention among Baltimore City's homeless population. *Public Health Nursing, 24*(1), 34-39. Retrieved from http://www.wiley.com/WileyCDA/WileyTitle/productCd-PHN.html

Lawn, S. D. & Zumla, A. (2011). Tuberculosis. *The Lancet, 378*, 57-72. doi: 10.1016/S0140-6736(10)62173-3.

Lin, H. H., Ezzati, M., & Murray, M. (2007). Tobacco smoke, indoor air pollution and tuberculosis: A systematic review and meta-analysis. *PLOS Medicine, 4* (1), 0173-0189. doi:10.1371/journal.pmed.0040020.

Lin, H. H., Murray, M., Cohen, T., Colijn, & Ezzati, M. (2008). Effects of smoking and solid-fuel use on COPD, lung cancer, and tuberculosis. *The Lancet, 372*, 1473-1483. Retrieved from http://www.thelancet.com/

Lonnroth, K., Jaramillo, E., Williams, B. G., Dye, C., & Raviglione, M. (2009). Drivers of tuberculosis epidemics: The role of risk factors and social determinants. *Social Science and Medicine, 68*, 2240-2246. doi: 10.1016/j.socscimed.2009.03.041.

Maartens, G. & Wilkinson, R. J. (2007). Tuberculosis. *The Lancet, 370*, 2030-2043. doi: 10.1016/So140-6736(07)61262-8.

McNamee, R. (2005). Regression modelling and other methods to control confounding. *Occupational and Environmental Medicine, 62*, 500-506. doi: 10.1136/oem.2002001115.

Maher, D. (2003). The role of the community in the control of tuberculosis. *Tuberculosis, 83*, 177-182. doi: 10.1016/S1471-9792(02)00066-5.

Multiple levels of exposure: Non-stratified analysis (2002). Retrieved from http://www.uic.edu/classes/epid/epid401/lectures/lecture8.pdf

Munro, B.H. (2005). *Statistical methods for health care research.* Philadelphia, PA: Lippincott, Williams, & Wilkins.

Myer, G. D., Kreiswirth, E. M., Kahanov, L., & Martin, M. (2009). Longitudinal evaluation of Journal of Athletic Training author credentials: Implications for future research engagement in athletic training. *Journal of Athletic Training, 44* (4), 427-433. Retrieved from http://www.nata.org/journal-of-athletic-training

Myers, W. P., Westenhouse, J. L., Flood, J., & Riley, L. W. (2006). An ecological study of tuberculosis transmission in California. *American Journal of Public Health, 96* (4), 685-690. Retrieved from http://www.apha.org/publications/journal

New Jersey Department of Health (2009). Tuberculosis statistics. Retrieved from http://www.state.nj.us/health/tb/documents/

New Jersey Association of Realtors (2013). Housing statistics: January 2013. Retrieved from http://www.realtor.com/newjersey/nbselnj.asp

Nicod, L. R. (2006). Immunology of tuberculosis. *Der Pneumologe,* 3(4), 266-272. Retrieved from http://www.springer.com/medicine/internal/journal/10405

Ompad, D. C., Galea, S., Caiaffa, W. T., & Vlahov, D. (2007). Social determinants of urban populations: Methodologic considerations. *Journal of Urban Health: Bulletin of the New York Academy of Medicine, 84*(1), i42-i53. doi: 10 1007/s11524-007-9168-4

Oren, E., Winston, C. A., Pratt, R., Robison, V. A., & Narita, M. (2011). Epidemiology of urban tuberculosis in the United States, 2000-2007. *American Journal of Public Health, 101*, 1256-1263. doi: 102105/AJPH.2010.3000030.

Pett, M. A. (1997). *Nonparametric statistics in health care research: Statistics for small samples and unusual distributions*. Los Angeles, CA: Sage.

Phillips, L. R. (1989). Age: a truly confounding variable. *Western Journal of Nursing , 11*(2), 181-195. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2658321

Pickett, W., Iannotti, R. J., Simons-Morton, B., & Dostaler, S. (2009). Social environments and physical aggression among 21,107 students in the United States and Canada. *Journal of School Health, 79* (4), 160-168. Retrieved from http://www.blackwellpublishing.com/journal.asp?ref=0022-4391

Piza, E. L. (2012). Using Poisson and negative binomial regression models to measure the influence of risk on crime incident counts. Retrieved from http://www.riskterrainmodeling.com

Poisson regression analysis. (n.d.). Retrieved from http://www.oxfordjournals.org/troupej/online/ma_chap13.pdf

Rehm, J., Samokhvalov, A. V., Neuman, M. G., Room, R., Parry, C., Lonnroth, K.,...Popova, S. (2009). The association between alcohol use, alcohol use disorders and tuberculosis (TB). A systematic review. *BMC Public Health, 9*, 450. doi:10.1186/1471-2458-9-450

Restrepo, B., Camerlin, A. J., Rahbar, M. H., Wang, W., Restrepo, M. A., Zarate, I.,…Fisher-Hoch, S. P. (2011). Cross-sectional assessment reveals high diabetes prevalence among newly-diagnosed tuberculosis cases. *Bulletin of the World Health Organization, 89*, 352-659. doi:10.2471/BLT.10.085738.

Rodriguez, G. (2007). Poisson models for count data. Retrieved from http://data.princeton.edu/wws509/notes/c4.pdf

Rodwell, T. C., Moore, M., Moser, K. S., Brodine, S. K., & Strathdee, S. A. (2008). Tuberculosis from Mycobacterium bovis in binational communities, United States. *Emerging Infectious Diseases, 14* (6). 909-916. Retrieved from http://wwwnc.cdc.gov/eid/

Russell, D. G., Barry 3rd, C. E., & Flynn, J. L. (2010). Tuberculosis: What we don't know can, and does, hurt us. *Science, 328*(5980), 852-856. doi: 10.1126/science.1184784.

Schmidt, C. W. (2008). Linking TB and the environment: An overlooked mitigation strategy. *Environmental Health Perspectives, 116* (11), A479-A 485. Retrieved from http://ehp03.niehs.nih.gov/home.action

Sepkowitz, K.A. (2001). Tuberculosis control in the 21st century. *Emerging Infectious Diseases, 7*, 259-262. Retrieved from http://wwwnc.cdc.gov/eid/

Sharpe, T. T., Harrison, K. M., & Dean, H. D. (2010). Summary of CDC consultation to address social determinants of health for prevention of disparities in HIV/AIDS, viral hepatitis, sexually transmitted diseases, tuberculosis. *Public Health Reports 125,* (suppl 4), 11-15. Retrieved from http://www.publichealthreports.org

Shieh, F. K., Snyder, G., Horsburgh, C. R., Bernardo, J., Murphy, C., & Saukkonen, J. J. (2006). Predicting non-completion of treatment for latent tuberculosis infection. *American Journal of Respiratory and Critical Care Medicine, 174*, 717-721. doi: 10.1164/rccm.200510-1667OC.

Snider, G.L. (1997). Tuberculosis then and now: a personal perspective on the last 50 years. *Annals of Internal Medicine, 126*(3), 237-243. Retrieved from http://www.annals.org

Thompson, S., Manderson, L., Woelz-Stirling, N., Cahill, A., & Kelaher, M. (2002). The social and cultural context of the mental health of Filipinas in Queensland. *Australian and Zealand Journal of Psychiatry, 36*, 681-687. doi: 10.1046/j.1440-1614.2002.01071.x

Tripepi, C., Jager, K. J., Dekker, F. W., & Zoccali, C. (2010). Stratification for confounding- Part1: The Mantel-Haenszel formula. *Nephron Clinical Practice, 116*, c317-c321. doi: 10.1159/000319590.

United States Census Bureau. (2009). American factfinder. Retrieved from http://2010.census.gov/2010census/data/

Walden University (n.d.). Tables to calculate necessary sample size. Retrieved from https://class.waldenu.edu/bbcswebdav/institution/USW1/

Wylie, J. L., Shah, L., & Jolly, A. (2007). Incorporating geographic setting into a social network analysis of injection drug use and bloodborne pathogen prevalence. *Health & Place, 13*, 617-628. doi: 10.1016.j.healthplace.2006.09.002.

Young, D., Stark, J., & Kirschner, D. (2008). Systems biology of persistent infection: Tuberculosis as a case study. *Nature Reviews Microbiology,* doi: 10.1038/nrmicro1919.

Zhou, J., Ito, K., Lall, R., Lippmann, M., & Thurston, G. (2011). Time-series analysis of mortality effects of fine particulate matter components in Detroit and Seattle. *Environmental Health Perspectives, 119*(4), 461-466. doi.10:1289/ehp.1002613.