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DISSERTATION

Impact of Demographic Characteristics and Therapy on Tuberculosis Incident Cases

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Abstract

For more than two decades, tuberculosis (TB) has ranked second among the top killers of infectious diseases, with an estimated 10.4 million incident cases in 2018. Demographic characteristics and drug susceptibility influence TB incidence worldwide. Using a retrospective cohort design, the purpose of this quantitative study was to investigate whether race/ethnicity, age, sex (gender), therapy completion within one year (COT), and testing for isoniazid and rifampin susceptibility (TIRS) were predictors of 672 cases of TB in New York-Newark-Jersey City from 1993 to 2017. Guided by the epidemiological triad theory, this research was conducted using a secondary TB dataset from the Center for Disease Control and Prevention. Analysis of the data with the Poisson regression model on SPSS revealed that Blacks, Hispanics, and Asians were respectively 2.4 (95% CI, 2.364 to 2.512, $p < 0.001$), 2.1 (95% CI, 2.031 to 2.161; $p < 0.001$), 1.8 (95% CI, 1.782 to 1.899; $p < 0.001$) times as likely to have TB compared to Whites. Younger age was significantly associated with higher incident cases of TB. Males were 1.58 (95% CI, 1.554 to 1.613, $p < 0.001$) times more likely than females to have the disease. The COT and TIRS were 0.175 (95% CI, 0.170 to 0.180, $p < 0.001$) and 2.935 (95% CI, 2.853 to 3.019, $p < 0.001$) times as likely to impact the TB incident cases in New York-Newark- Jersey City from 1993 to 2017. The findings of this research may create positive social change by informing public health professionals in the design of an effective TB intervention that addresses demographic and therapy-related risk factors for TB in New York-Newark-Jersey City.

Chapter 1: Introduction to the Study

Introduction

Despite the directed priorities of New York City Department of Health in providing healthcare and treatments for TB patients, the race/ethnicity and covariates, age, sex (gender), and issues of TB therapy completion and drug susceptibility persistently influenced the escalation of TB incidence in New York-Newark-Jersey City. According to research, non-Hispanic Asians, non-Hispanic Blacks, and Hispanics have regularly experienced more TB incident cases than their non-Hispanic White counterparts from this region in New York City [1-5]. Notably, both the age and sex demographics have impacted the incidence of TB in New York-Newark-Jersey City. Regardless of their gender or age groups, the non-Hispanic Asian, non-Hispanic Black, and Hispanic residents have persistently experienced the highest burden of TB in New York-Newark- Jersey City [6,7,4]. Therefore, race/ethnicity, age, and sex risk factors impacted the elevated incident cases of TB in this area in New York City.

Previous studies partially established the relationship between the demographic characteristics of patients and the incidence of TB in New York-Newark-Jersey City. However, the results did not clearly demonstrate the impact of TB on non-Hispanic Asians, non-Hispanic Blacks, Hispanics, and non-Hispanic Whites from 1993 to 2017 in New York-Newark-Jersey City. Poverty, alcohol consumption, poor housing, and lack of access to TB care risk factors associated with the high TB incident cases among the non- Hispanic Black and Hispanic TB patients in New York-Newark-Jersey City Sanderson, et al. (2015 [8,9,5]. In addition, researchers found that tobacco use is a contributing risk factor for the burden of TB among non-Hispanic Asians at this specified location in New York City [4]. However, these researchers did not clearly indicate the reasons for the low burden of TB incidence

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among the non-Hispanic Whites from this location in New York City. Therefore, the purpose of this study was to investigate the relationship between the individuals' race/ethnicity, age, sex (gender), completion of therapy within one year, testing for isoniazid and rifampin susceptibility, and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

The results of this study could create positive social change by promoting the design of an effective TB intervention about the individuals' race/ethnicity and covariates, age, sex (gender), and issues of therapy and drug susceptibility in New York- Newark-Jersey City. Chapter one of this study includes background information on TB, the problem statement, and the rationale for conducting this research from this area in New York City. Additionally, it encompasses the nature of the study, research questions and hypotheses, definitions, assumptions, limitations, significance, and a summary section. It is worthwhile noting that TB is an emerging infectious disease affecting the livelihood of people worldwide.

Background of Tuberculosis

TB incidence is historically associated with specific demographic characteristics of patients and treatment issues. Lin, et al. (2013) and Noppert, et al. [10] indicated that researchers have regularly found the race/ethnicity, age, and sex (gender) demographics as contributing risk factors for the incidence of TB in a given population. Zhang, et al. (2011), argued about the disparity in race/ethnicity, age, or sex (gender) of persons as the contributing risk factors for different paths of exposures to TB in most advanced and developed countries in the world. From a therapeutic approach, the issue of TB therapy has recently challenged the goal of ending TB, globally. In 2017, more than 30% of the global TB diagnoses have been connected to the multidrug-resistant issue, including the rifampin TB drug treatment [11]. Despite the amelioration in TB diagnosis and the availability of drug treatments, the complications in therapy and drug susceptibility have recently impacted the global incidence trends of TB.

The issues of TB therapy and treatments present a burden for eradicating TB, globally. The exposure of TB patients to isoniazid and rifampicin drug treatments is often associated with poor treatment outcomes among many TB patients in the world [12,13,11].

However, the lack of adherence to some patients in completing TB therapy is also associated with the increasing number of TB incident cases worldwide. Similarly, the failure of some patients to adhere to the quality of care and medications for their TB disease is a global problem [14,11]. This behavior is often associated with unsuccessful treatment stories and a high incidence of the disease worldwide [14,11]. The health beliefs of some TB patients have also prevented them from obtaining the quality of care required to cure their TB disease.

The conceptions of some patients about TB are contributing risk factors for the incidence of TB worldwide. These perceptions are characterized as the health beliefs and misconceptions of some patients about their TB disease [15-17]. Religious beliefs in using holy water and misconception about the appropriate time for receiving TB treatments are also associated with the high incidence of the disease within their communities [15-17]. Bullying is also associated with the lack of or non-adherence of some patients to TB care.

Bullying has an influence on the morbidity and mortality of TB worldwide. As such, the stigmatization has been found to be attributed to the delays of TB diagnoses and treatments among many TB patients worldwide [15-17]. Additionally, a lack of or low adherence to TB care and treatments often led them to experience the atrocity and high mortality rate of TB [14,11]. However, the cost of TB care is exorbitant.

The high cost of health care is a contributing risk factor for the elevated incidence of TB in some parts of the world. The lack of health insurance coverage and high cost of TB care and treatments are also attributing risk factors for the escalation of TB incidence in several communities in the world [15-17]. TB is a global health threat to humanity.

Despite its decline in other areas of the world, TB has continued to affect people in the United States. However, its incident cases have been substantially decreased starting from 2013 to 2017 [18-22]. Additionally, the TB incident cases were varied by the individuals' demographic characteristics within several communities in the United States. The heterogeneity in the incident cases of TB in the United States has long been associating with the race/ethnicity, age, sex (gender), and country of origin of some TB patients [19,23,4,9,5]. Similarly, non-Hispanic Asian, non-Hispanic Black, Hispanic, Native Hawaiian, and other Pacific Islander persons have experienced a disproportionate burden of TB incident cases, regardless of their age and gender orientation in the United States [24,21,22]. As such, the demographic characteristics of patients had influenced the escalation of TB incidence between 1993 and 2017 in New York-Newark-Jersey City.

Despite its reduction nationally, the reported TB incident cases have been consistently high in New York-Newark-Jersey City. From 2010 to 2013, the incidence of TB estimated to approximately 8.7 cases and slightly decreased to 7.5 cases per 100,000 in 2017 from this area in New York City [25,4]. The demographic characteristics of patients partially influenced the incident cases TB for more than 25 years in New York-Newark-Jersey City.

Researchers have shown the influence of race/ethnicity, age, and gender of patients in the high

incidence rate of TB in New York-Newark-Jersey City. However, little is known about the impact of TB therapy incompletion and drug susceptibility on the elevated incident cases of TB for more than a decade from this region in New York City. Recently, the issues of therapy and drug susceptibility have been evaluated as the potential risk factors for the increased TB incident cases, globally. Likewise, the race/ethnicity and its covariates, age and gender have been influential in the increased incident cases of TB worldwide.

For the past five years, the highest TB incident cases have been detected in Asian, African, and Hispanic countries. Likewise, race/ethnicity, age, and sex (gender) demographics have been influential in the increased TB incident cases in New York- Newark-Jersey City. Consequently, this study may be of immense public health significance by exploring whether the race/ethnicity, age, and sex (gender) of patients associated with the elevated TB incident cases between 1993 and 2017 from New York- Newark-Jersey City. Additionally, the significance of this study is in its originality by attempting to determine whether the issues of TB therapy and drug susceptibility were connected to the phenomena of TB in New York-Newark-Jersey City.

Problem statement

Demographic characteristics and issues of therapy completion and drug susceptibility have influences on the burden of TB incidence in New York-Newark- Jersey. From 2013 to 2017, non-Hispanic Asian, non-Hispanic Black, and Hispanic individuals experienced the highest burden of TB incidence from New York-Newark- Jersey City (New York City Bureau of Tuberculosis Control, 2016) [9,5]. In contrast, their non-Hispanic White counterparts regularly experienced a low burden of TB in New York- Newark-Jersey (New York City Bureau of Tuberculosis Control, 2016, p. 16) [9]. Hence, these demographic characteristics have been influential risk factors for the incidence of TB during the past decade in New York-Newark-Jersey City.

The age demographic is a contributing risk factor for TB in New York-Newark- Jersey City. (Sanderson, et al. (2015) [8] estimated that the affliction of TB is associated with more elders and children, aged five and under in the above area of New York City. As such, the gender demographic is also an attributable risk factor for TB in New York-Newark-Jersey City. Being female is a risk factor for getting TB from this metropolitan area of New York [26,9]. More specifically, females are more likely than their male counterparts to be diagnosed with TB in New York-Newark-Jersey City [26,9]. Researchers have argued that the individuals' race/ethnicity, age, and gender are partially influenced by the elevated TB incident cases from 2012 to 2017. However, they have not indicated how these demographic characteristics of patients were associated with the increasing TB incident cases from this region in New York City.

There is uncertainty in the risk factors for TB in New York-Newark-Jersey City [4,9] argued that substance and tobacco use and alcohol consumption are associated risk factors for the high burden of TB among non- Hispanic Asians, non-Hispanic Blacks, Hispanics, and some non-Hispanic White persons New York-Newark-Jersey City. However, living in incarceration and in health care facilities are also the contributing risk factors for the upsurge TB incident cases in New York-Newark Jersey City from 2013 to 2017 [26,21].

Thus, the residence is a risk factor for TB transmission in New York-Newark-Jersey City.

Poor housing is a potential risk factor for TB in New York-Newark-Jersey.

Sanderson, et al. (2015), Stennis, et al. [9] and Slutsker, et al. [8] argued that living in poor houses or buildings is associated with transmitting TB from person to person in New York-Newark-Jersey City. It has also been argued that high cost of TB care and treatments are related to the increasing TB incident cases among the poor and migrant persons at this specific location in New York City [27,6,5]. Furthermore, the lack of adherence of some patients to TB care and treatments is a potential risk factor for the reoccurring TB incident cases in New York- Newark-Jersey.

The lack of or non-adherence of some patients to TB care and treatments are common risk factors for an increasing incidence of TB in a population. Bhavnani, et al. [27], Bushnell, et al. [6], Zelnick, et al. [5] contended that the inadequate adherence of some TB patients to seeking care has often resulted in the interruption of and incomplete treatments and high incidence of TB in New York-Newark-Jersey City. Researchers have shown the influence of demographic characteristics of patients on the incident cases of TB from 2012 to 2017 from this area in New York City. However, little research has been conducted about the impact of inadequate TB therapy completion and drug susceptibility issues on TB incident cases in New York-Newark-Jersey City.

Purpose of the Study

The purpose of this quantitative study was to investigate the relationship between demographic characteristics, issues of therapy completion, isoniazid and rifampin susceptibility, and the TB incident cases between 1993 and 2017 in New York-Newark- Jersey City. Using the retrospective cohort study design, this quantitative analysis was conducted by using the 1993-2017 TB dataset from the online tuberculosis information system (OTIS) database of the CDC. Of this dataset, the age, sex, race/ethnicity, completion of therapy within one year, and testing for isoniazid and rifampin susceptibility were the independent variables for this study. The TB incident cases were the dependent variable for this research. The Poisson regression model was used for the analysis of data associated with these variables.

Research questions and hypotheses

The following research questions and hypotheses were formulated using the variables, race/ethnicity, age, and sex, completion of therapy within one year, tested for isoniazid and rifampin susceptibility, and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

*RQ*1. Is there a relationship between race/ethnicity and covariates (age and sex), and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City?

H0 1. There is no relationship between race/ethnicity and covariates (age and sex), and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

H1 1. There is a relationship between race/ethnicity and covariates (age and sex), and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

*RQ*2. Is there a predictive relationship between the completion of therapy within one year and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City?

H0 2. There is no predictive relationship between the completion of therapy within one year and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

H1 2. There is a predictive between completion of therapy within one year and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

*RQ*3. Is there a predictive relationship between tested for isoniazid & rifampin susceptibility the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City?

H0 3. There is no predictive relationship between tested for isoniazid & rifampin susceptibility the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

H1 3. There is a predictive relationship between tested for isoniazid & rifampin susceptibility and the TB incident cases between 1993 and 2017 in New York-Newark- Jersey City.

Theoretical framework

The epidemiological triad theory is commonly used to guide the investigation of an infectious disease in a given population. This theory is appropriate for exploring the age and gender of infected persons and environmental risk factors connected to the occurrence of an infectious disease in a population. The epidemiological triad theory was useful in helping me with exploring the relationship of race/ethnicity, age, sex of TB patients, and the TB incident cases from 2011 to 2018 in New York-Newark-Jersey City.

The epidemiological triad theory is relevant to this study. According to the CDC 2012 [28], Morabia [29] this theory is the best philosophical perspective for investigating an infectious disease from a population. Additionally, the epidemiological triad theory is fundamental to understanding the host-pathogen interaction from various environmental risk factors in a given population [28,29]. The environmental risk factors may be based on the issues of geology, climate, biological, and socioeconomic status (e.g., crowding, sanitation, & availability of health services) of people in an environment [28]. As such, the epidemiological triad theory is relevant to this research on the interaction of *Mycobacterium tuberculosis* with the human host in New York-Newark-Jersey City.

Nature of the study

This study was a quantitative analysis focused on a retrospective cohort study to investigate TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. A quantitative study allows researchers to collect and analyze an existing dataset to interpret an outcome of interest from a population [30,31]. The Poisson regression model was used to analyze the relationship between race/ethnicity, age, and sex demographics, completion of therapy within one year, testing for isoniazid and rifampin susceptibility, and the TB incident cases from New York-Newark-Jersey City during 1993-2017.

Terms and definitions

***Active and latent tuberculosis*:** active TB has often exhibited its symptoms in an infected host; however, the latent state of TB is asymptomatic inside the infected host [32-34].

***Airborne disease*:** is an infectious disease caused by pathogens expelled and suspended in the air through the droplet nuclei (e.g., coughing and sneezing) of an infected person and transmitted to other persons inhaling them in a given environment [35].

***Communicable disease*:** is a contagious disease caused by an infectious agent through direct contact with an infected person or indirectly from other sources in an environment [36].

***Demographic characteristics*:** are numerous characteristics (e.g., age, gender, race/ethnicity, income level, education level, marital status, geographic areas, etc.) of a study population [37,38].

***TB drug susceptibility testing*:** is a term denoting intolerability of the *Mycobacterium tuberculosis* species to some TB drug treatments in some TB patients [39].

Foreign-born persons: the persons, who were not born in the U. S., but may become naturalized U.S. citizens [40].

***Host*:** is defined as a human being or an animal that is used as a reservoir of an infectious disease [41].

Table 1: Descriptive statistics between the independent and dependent variables of the study.

	N	Mean	Variance
Reported tuberculosis cases	604	77.0066	60996.832
Valid N (list wise)	604		

Mycobacterium tuberculosis: is the causative agent of the TB disease [24]

***New York-Newark-Jersey City*:** "is the largest metropolitan area in the United States" (Table 1) [42]

Race/ethnicity: has referred to the racial and ethnic background of a person [25] While Hispanics are originated from various races, Asians, Blacks, Whites, American Indian/Alaska Natives, Native Hawaiians or other Pacific Islanders, and multi-racial individuals are considered as the non-Hispanic ethnic groups [25]

Socioeconomic status: is the social and economic conditions, which have often determined the eligibility of persons in accessing health care in a given community (Towne, 2017).

U.S. born persons: the persons that are eligible to become the citizens of the United States at birth, regardless of the land, where they were born [43].

Assumptions

An assumption about the incidence of TB in New York-Newark-Jersey City was that the disease affected the persons of diverse ethnicities through various risk factors. Researchers found different kinds of risk factors associated with the incident cases of TB from 2011 to 2017 from this area in New York City. Another assumption of this research was that the illegal immigration status could represent a barrier for the Hispanic and Asian ethnic groups in accessing care and treatments for their TB disease. Such a challenge could lead them to experience a surmounted level of TB incident cases in New York-Newark-Jersey City. A key assumption was that the low socioeconomic status of the non-Hispanic Asian, non-Hispanic Black and Hispanic ethnic minorities could influence their high burden of TB incidence from this region in New York City. Although these assumptions were likely accurate, there was heterogeneity in how the residents of New York-Newark-Jersey City are affected by TB.

Scope and delimitations

Research has indicated a relationship between race/ethnicity, age, and gender of patients, and the incident cases of TB in New York-Newark-Jersey City. However, in this study, the scope is limited to demonstrating how the demographic characteristics of TB patients directly exposed them to TB in this area of New York City. Previous studies on TB indicated that the non-Hispanic Asian, non-Hispanic Black, and Hispanic individuals have experienced the highest burdens of TB from this region in New York. However, there is ambiguity in the reasons for a disadvantage in TB incident cases among ethnic minorities in this area of New York City. Also, the researchers of these studies did not investigate the connection between TB therapy completion, drug susceptibility, and the trends of TB incidence in New York-Newark-Jersey City. Moreover, these studies were not guided by a theoretical or conceptual framework through which the relationship between race/ethnicity, age, sex (gender) of patients, and the incident cases of TB could be investigated in this metropolitan area of New York.

For this study, the epidemiological triad theory was adopted as the philosophical guidance for exploring the relationship between the race/ethnicity, age, and sex demographics, therapy completion within one year, testing for isoniazid and rifampin susceptibility, and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. The theorist of this framework has suggested researchers can use the theory to understand the relationship between an infectious agent, host, and environmental risk factors that may provoke the incidence of such an infectious disease in a population.

Thus, this theory was feasible for exploring how the non-Hispanic Asian, non-Hispanic Black, Hispanic, non-Hispanic Whites, and multiracial persons directly related to the incident of TB during 1993-2017 in this area in New York City. This study was designed to represent the general population of TB patients in New York-Newark-Jersey City.

Limitations

Using the publicly available 1993-2017 TB dataset was considered a limitation to this study. However, such a limitation was minimal knowing that the CDC, a reputable agency for collecting health data, was the collector and organizer of the TB dataset.

Because I was not the primary collector of the above TB dataset, I was unable to control for the inherent biases associated with collecting data from the TB patients in New York- Newark-Jersey City from 1993-2017. This study was also limited in analyzing data of certain ethnic groups of TB patients because of the missing data and cases, with zero values from the 1993-2017 TB data set for New York-Newark-Jersey City. Notably, the cases, with excess zero values were inconclusive by not indicating whether the members of a certain ethnic group were affected by TB between 1993 and 2017 in New York- Newark-Jersey City (see CDC, 2018). Consequently, the statistical analysis of this research was strictly limited to the availability of data and variables reported in the OTIS database.

Significance

This study may be of immense public health significance by emphasizing the need for an effective TB intervention focusing on the demographic characteristics of TB patients, issues connected to therapy completion and isoniazid and rifampin susceptibility, and prevention of future TB occurrences in New York-Newark-Jersey City Stennis, et al. [4], Stennis, et al. [9], Zelnick, et al. [5] argued that foreign births, poverty, lack of insurance coverage, illegal immigration status are the contributing risk factors for the elevated incident cases of TB from this area in New York City. However, little research was conducted on the impact of inadequate TB therapy completion and drug susceptibility issues on the escalation of TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

Investigating the relationship between the individuals' race/ethnicity, age, and sex (gender), therapy incompletion, isoniazid, and rifampin susceptibility, and the TB incident cases between 1993 and 2017 was imperative for working toward eradicating TB in New York-Newark-Jersey City. The findings of this study might impact positive social change by evoking the public health professionals to design a TB intervention focused on issues connected to demographic variables, therapy incompletion, and isoniazid and rifampin susceptibility in this area in New York City. Likewise, it is important to educate the non-Hispanic Asian, non-Hispanic Black, Hispanic, non-Hispanic White, and multiracial ethnic groups about TB risk factors in this area in New York City. The findings of this study may also be helpful in advancing the knowledge of TB research.

Summary

In Chapter 1, I discussed evidence on the relationship between the demographic characteristics of patients and TB incident cases between 2011 and 2017 in New York- Newark-Jersey City. Additionally, this chapter included the rationale for conducting this TB research in New York-Newark-Jersey City, the purpose of the study, nature of the study, research questions and hypotheses, theoretical foundation, terms and definitions, assumptions, limitations, and significance of this study. In Chapter 2, I provide a review of the literature on the demographic characteristics of TB patients and therapy issues in New York-Newark-Jersey City.

Chapter 2: Literature Review

Introduction

The purpose of this study was to investigate whether the demographic characteristics of TB patients and issues related to TB therapy completion and isoniazid and rifampin susceptibility were associated with the escalation of TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. The hypotheses of this research included the independent variables of race/ethnicity, age, sex (gender), cases that completed therapy within one year, and the cases with initial susceptibility to isoniazid and rifampin. The dependent variable was TB incident cases during 1993 to 2017 in New York-Newark-Jersey City. Many researchers indicated that these demographic characteristics of TB patients have influenced the burden of TB incidence between 2011 and 2018 in this area in New York City. However, there is little research on the relationship between TB therapy completion, drug susceptibility issues, and the phenomena of TB in New York-Newark-Jersey City. Therefore, the purpose of this study was to investigate the relationship between the individuals' race/ethnicity, age, sex (gender), completion of therapy within one year, testing for isoniazid and rifampin susceptibility, and the TB incident cases from 1993 to 2017 in New York-Newark-Jersey City.

Chapter 2 of this study includes reviews of the literature on the epidemiology and pathophysiology of TB, and TB diagnoses and treatments in New York-Newark-Jersey City, the United States, and abroad. Additionally, I discuss the epidemiological triad theory and its applicability to this study based on previous studies of TB.

Literature search strategy

The literature search strategy involved in the use of databases from the Walden University Library to obtain evidence related to the incidence of TB in New York- Newark-Jersey City. Of the various databases, the *Medline with Full Text, PubMed, CINAHL Plus* with Full Text, and *ProQuest Central* were selected to find the peer-review articles for this study. The literature search was narrowed to peer-review articles and journals that were published within five years or less. Furthermore, evidence on the incidence of TB in New York City, United States, and abroad was sought using the websites of WHO, CDC, and New York City Bureau of Tuberculosis Control. As the following keywords were used in the search: *race/ethnicity, age*, *gender, health care services, tuberculosis, socioeconomic status, therapy issues, Tuberculosis drug-resistant,* and *New York*. In many instances, the search was narrowed to *text or title* as a strategy to obtain the articles for this research on TB.

Theoretical foundation

The epidemiological triad theory was served as the guidance of this study. A theoretical framework is the foundation of the literature review in a research study [44]. Such a component of research has, in part, informed about the structure, research questions, and hypotheses of a study [44]. From these perspectives, the research questions and hypotheses of this study were formulated using the independent variables, age, sex (gender), COT, and TIRS to investigate the incident cases of TB in New York-Newark-Jersey City during 1993-2017. Notably, the incidence of an infectious disease

may be based on various environmental risk exposures of a population.

The epidemiological triad theory predicts these environmental risk exposures as the socio-economic conditions, under which a community has lived in [28]. These conditions may be linked to inadequate health care services, poor hygiene, and overcrowding housings that have often exposed the members of a community to an infectious disease [28]. In this study, the issues of therapy and drug susceptibility were, in part, considered as the conditions that influenced the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017.

The epidemiological triad theory has not assumed race/ethnicity to be an intrinsic risk factor for infectious disease in a population. However, the relationship between race/ethnicity and the incidence of TB was investigated in New York-Newark-Jersey City during the past 25 years.

Literature review epidemiology of tuberculosis

TB is catastrophic across the globe. The pandemic of TB has been estimated to more than 10 million new cases yearly, starting from 2014 to 2018 [14,11,45] and more than 2 billion latent cases from 2014 to 2018 worldwide [13,46,47] However, the epidemiological trends of TB have been influenced by other health issues.

For the past five years, human immunodeficiency virus (HIV) patients have been vulnerable to acquiring and developing TB. For instance, HIV infected patients had the highest incidence of TB from 2012 to 2017 worldwide [48,14,11,45] In addition, the global morbidity and mortality rates of TB have been recently elevated. From 2012 to 2017, the global mortality rate of TB was estimated at 1.3 million cases yearly [49,50,51] However, the HIV infected patients were more likely to die from TB than their counterparts who did not have the HIV infection [48,52,11].

However, TB is more detrimental to some persons in some countries and regions in the world. For the past 25 years, TB has been more common in certain continents and regions of the world. For instance, the Eastern area of Asia was the most afflicted region, with more than 40% of the world's TB epidemic from 2013 to 2017 [14,11,45]. Likewise, the African and Western Pacific regions ranked second and third, with approximately 25% and 17 % of the global TB incident cases respectively in 2016 [11,45] However, the Eastern Mediterranean, European, and Americas correspondingly accounted for nearly 8%, 3%, and 3%, respectively, of the global incidence rate of TB from 2012 to 2017 [14,11,45].

TB is a multifaceted infectious disease with various risk exposures. From 2012 to 2017, malnutrition, smoking habit, diabetes, HIV, and poverty have been evaluated as the most frequent risk factors for the incidence of TB worldwide (Millet, et al. 2013) [49,53,11]. HIV infection and drug resistance, however, have been evaluated as the most challenging risk factors controlling for TB across the globe during 2012-2017 (Millet, et al. 2013) [14,45]. Additionally, HIV patients are more likely than those without HIV to develop TB, and most of them have lived in low-income countries in Africa and Asia (Millet, et al. 2013) [14,45].

Drug resistance is associated with elevated incident cases of TB worldwide. From 2013 to 2018, multidrug-resistant TB (MDR-TB) and extensive drug-resistance were among the most dominant risk factors for treatment failure among TB patients worldwide (Millet, et al. 2013) [14,45]. Most of the MDR-TB cases were detected in Eastern Europe and Central Asia during 2013-2016 TB incidence worldwide (Tupasi, et al. 2016) [14].

Race/ethnicity is an associated risk factor for the incidence of TB in the United States. The national incidence rate of TB in the United States is estimated between 2.8 and 3.0 cases per 100,000 from 2012 to 2016 [20,21,54,22]. However, the incidence rate of TB among people outside of the United States is estimated to more than15.0 cases per 100,000 [20,21,22].

However, there is a disparity in the distribution of TB among people outside of the United States. There is heterogeneity in the attribution of people outside of the United States to the incident cases of TB within the United States. Non-Hispanic Asians persistently experienced the highest burden of TB, with approximately 27 cases per 100,000, followed by non-Hispanic Blacks and Hispanics, with roughly 22 and 10.0 cases per 100000 [20,21,22]. However, regarding country of origin, Mexico-born persons, people born in the Philippines, Indians, the Vietnamese, and Chinese immigrants attributed more than 50 % of the national TB incident cases from 2014 to 2017 in the United States [21,54,22]. Although the people outside of the United States have had the highest burden of TB, American-born persons are also infected with the disease.

The incident cases of TB are low among American-born persons. From 2012 to 2017, the incidence rate of TB has been estimated between 1.0 and 1.8 cases per 100000 American-born persons in the United States [20,21,22]. However, this ethnic group of TB patients has experienced the disparity in their attributions in the incident cases of the disease nationally. From 2014 to 2017, non-Hispanic Blacks experienced a disproportionate burden of nearly 30% of the TB incident cases among American-born TB patients [54,21,22]. Conversely, Schmit, et al. [21] and Stewart, et al. [22] estimated that the Native Hawaiians and Pacific Islanders had the highest burden of TB, with approximately 6.5 cases per 100,000 during this period in the United States. On the other hand, Schmit, et al. [21] and Stewart, et al. [22] argued that the American Indians/Alaska Natives and non-Hispanic Blacks are

categorized as the second and third ethnic groups, with the highest TB incident rates of approximately 3.6 and 2.8, respectively in the United States. TB has also infected other American-born persons.

Among the American-born persons, the non-Hispanic Asian, Hispanic, and non- Hispanic White Americans have experienced the lowest TB incidence rates. These ethnic groups accounted for approximately 2.0, 1.5, 0.4 TB incident cases per 100, 000, respectively from 2014 to 2017 in the United States [54,22,21]. However, regardless of its disparity across diverse ethnic groups, TB is a public health threat in several states, communities, and regions in the United States.

Despite its low incidence on the national level, TB has impacted the livelihood of hundreds of persons in New York-Newark-Jersey City, yearly. Lately, the incidence rate of TB in New York City varied from 8.0 cases in 2012 to 7.4 in 2014, and 7.5 cases per 100,000 in 2017 [55,6,56]. Such an escalation of TB incidence in this part of New York associated with the youths (e.g., ages 18 and under) and elders (e.g., age 65 and older), males, foreigners, and the U.S.-born Hispanics [56,5]. The high incidence of TB in New York-Newark Jersey City associated with the lack of TB care and treatment for some TB patients.

The issues of TB care and treatments are linked to the high TB incidence rate in New York-Newark-Jersey City. From 2012 to 2017, the delays in TB diagnoses and treatments have been associated with the escalation of TB incidence in this area of New York City [57,56]. Also, the race/ethnicity demographic has an influence on the elevated incident cases of TB for the past decade from this region in New York.

The race/ethnicity risk factor is associated with the high incident rate of TB in New York-Newark-Jersey City. From 2014 to 2018, non-Hispanic Asian, non-Hispanic Black, Hispanic, and non-Hispanic White foreigners experienced more than 15 incident cases of TB per 100,000 from this area in New York City (New York City Bureau of Tuberculosis Control, 2016); [54,22]. Conversely, the U.S.- born Asians, Blacks, Hispanics, and Whites only accounted for 6.3 cases per 100, 000, combined (New York City Bureau of Tuberculosis Control, 2016). Educated on the pathology of the *Mycobacterium tuberculosis* species is also important for physicians and public health professionals to eradicate TB in New York-Newark-Jersey City.

Pathophysiology of tuberculosis

TB is an airborne and communicable disease. Such an infectious disease is transmissible from person to person [14,35,58]. Often, a person has acquired TB by inhaling the *Mycobacteria* from coughing, speaking, and sneezing of a TB-infected person [14,35,58,59] After inhaling the *Mycobacterium tuberculosis,* a person may develop either the active or latent state of TB depending on the strength of the immune system of this person [60,50,61]. While the *Mycobacterium tuberculosis* has remained latent in patients of strong immune systems, it has changed into active in those, with weak or compromised immune systems [50,62,63] The *Mycobacterium tuberculosis* is subdivided into several types.

Understanding the diversity in characteristics of the *Mycobacterium* species is important for an effective TB diagnosis. Although the *Mycobacterium* species are of different types, they are similar in low permeability of their cell walls [64,65]. However, these microorganisms are different in infecting either humans or animals. Whereas *Mycobacterium tuberculosis and Mycobacterium Bovis* have infected humans and animals, the *Mycobacterium Canettii* and *Mycobacterium Africanum* species have only infected humans [66,64]. Contrarily, the *Mycobacterium Caprae* has infected goats, *Mycobacterium microti* has infected the immunocompromised persons, and *Mycobacterium pinnipedii* is often seen in infected seals [66,64]. At the cellular level, the *Mycobacterium tuberculosis* species has attacked the alveolar organ of the host.

The *Mycobacterium tuberculosis* agent has disabled the alveolar macrophage to infect the lungs of its host. Research indicated that the macrophage is an antigen that has engulfed or killed the foreign particles attempting to invade the immune system of a host [67,68,59]. However, in many instances, the *Mycobacterium tuberculosis* species has been observed in inhibiting the function of T-lymphocytes and immune response of the alveolar macrophages to survive within a TB-infected person or animal [68,69,59]. Once escaping the acidic environment of the alveolar macrophages, the *Mycobacterium tuberculosis* can infect the lungs of its infected host [70]. Thus, the disability of alveolar macrophages is proportional to the ability of *Mycobacterium tuberculosis* species in infecting the lungs.

The inflammatory condition of alveolar has become a suitable environment for the development of TB. Of the granulomatous or inflammatory cell structure of the lungs, the *Mycobacterium tuberculosis* agent has transformed itself into the pulmonary TB infection Rodrigues, et al. (2013) [59,70] The contagious TB infection, however, has remained latent in patients with strong immune systems and active in those of weak immune systems [71,72]. While the cellular interaction of *Mycobacterium tuberculosis* has informed about the immune system of the host, education on the molecular aspect of this *Mycobacterium* species is crucial for diagnosing and treating TB patients.

Studying the molecular interaction of *Mycobacterium TB* is of immense public health significance to eradicate tuberculosis worldwide. Research indicated that having educated on the relationship of the molecular kinetics

with specific strains of *Mycobacterium tuberculosis* in the immune system of a host is critical for making an effective vaccine for TB [73,74,71]. Such a suggestion has been made based on the variability in the interaction of the *Mycobacterium tuberculosis* inside the immune system. Likewise, previous studies indicated that the *Mycobacterium tuberculosis* has often interacted with many types of cytokines to infect the lungs of its host [67,73,74]. Thus, the interaction of *Mycobacterium tuberculosis* has involved several types of cytokines while causing TB within the lungs of an infected person or animal.

Depending on its strain, the *Mycobacterium tuberculosis* species have behaved differently with specific types of cytokines. The H37Rv strain of *Mycobacterium tuberculosis*, for instance, might inhibit the macrophages from secreting tumor necrosis factor (TNF) and interleukin-12 (IL-12) cytokines that may have prevented it from invading the immune system of a host Olsen, et al. (2016) [67,75] The dysfunction of macrophages is critical for the survival of *Mycobacterium tuberculosis* inside the host. Similarly, research indicated that such an action of the H37Rv strain has often sustained the *Mycobacterium tuberculosis* agent in obliterating the production of TNF and nitric oxide in its favor to survive, grow, and transform into pulmonary tuberculosis within the immune system of such a host Olsen, et al. (2016) [67,75,74] The K-strain of the *Mycobacterium tuberculosis,* on the contrary, has interacted with different kinds of cytokines within the immune system of the host.

The interaction of K-strain of *Mycobacterium tuberculosis* is critically important for developing a vaccine and an effective diagnosis of TB. Kim, et al. (2015) [73] and Park, et al. [76] and argued that the K-strain of *Mycobacterium tuberculosis* is an informative tool for differentiating the latent and active TB in diagnosing patients, suspected with the disease, and in those that are susceptible to TB drug treatments. Unlike the H37Rv, the K-strain of *Mycobacterium tuberculosis* regularly disabled the production of IFN-γ and IL-17 cytokines causing TB in the lungs of a host [60,76,73]. Additionally, the K-strain of *Mycobacterium tuberculosis* has been estimated to be a more toxic cytokine than its counterpart H37RV strain in producing granulation or inflammation to the lungs of a host [73,77,78]. While the immune response has differed with various strains of the *Mycobacterium tuberculosis* species, the molecular interaction of this microorganism is fatal to the immune system of its infected host.

The worst actions of the *Mycobacterium tuberculosis* have been seen in its molecular interaction. Of such a biological interaction, the lungs of TB patients have developed the cavitation and necrosis mechanism Butler, et al. (2017); [78,70,79]. Under the necrotic condition, *Mycobacterium tuberculosis* has disabled the mitochondria and plasma membrane easing the entry of the infected *Mycobacteria* into the alveoli macrophages Butler, et al. (2017); [78,70] Through the process of necrosis, *Mycobacteria* have grown extensively and formed the cavitation in the lungs of a host Butler, et al. (2017), [78,80]. During this evolution, TB has become contagious by releasing of extensive amount of bacilli on the air from coughing or sneezing of a TB-infected person to other uninfected ones in a given environment Butler, et al. (2017), [78,70,80]. Thus, understanding the molecular function of the *Mycobacterium tuberculosis* within the immune system of a host is crucial for diagnosing and preventing TB in a given population.

Diagnosis of tuberculosis

Careful diagnosis of TB is imperative for the global eradication of the disease. However, effective diagnoses of TB have required the in-depth TB knowledge of physicians to contribute to the elimination of this infectious disease worldwide [81,82]. Likewise, these healthcare providers could help achieve the goal of eliminating TB globally, with their accuracy in diagnosing and treating TB patients [32,83]. Thus, the knowledge of the physicians in TB is needed for an accurate diagnosis of the disease.

To be effective in testing patients for TB, the health care providers must know the symptoms of the disease. These health care providers might be successful in diagnosing TB, with their careful analyses of sputum of their patients within the first few weeks of exposure to the *Mycobacterium tuberculosis* species [84,83]. Additionally, they must familiarize themselves with symptoms, such as chest pain, fatigue, weight loss, lack of appetite, chills, fever, sweating at night times to be effective in detecting TB in their patients [85,32,58,34]. Knowing the symptoms of TB is also important for examining patients; however, the process of diagnosing them is a challenge. Diagnosing TB is complicated. Such a challenge is associated with the inaccuracy connected to the tuberculin skin test (TST) and QuantiFERON-TB-Gold assay (QFT- GIT) diagnostic techniques in testing patients suspected with TB [86,87,88] Often, the TST has been used for diagnosing patients suspected of TB, but it is limited in revealing whether the infection is latent or active [86,87,88]. Additionally, the TST often yielded false positive or false negative results analyzing the bloodstream of some patients under investigation for TB [86,87,88]. In many instances, the inaccuracy of TST has necessitated other advanced examinations for TB in many patients. A chest X-ray is a more tangible test for examining patients suspected with.

Often, many health care providers used a chest x-ray exam to analyze if TB is active or latent in their patients [86,89,32]. The difficulty associated with TB diagnoses has obligated some healthcare providers to be selective in their methods of diagnosing persons suspected with the disease. The detection of latent TB

is dynamic. Auguste, et al. (2016) [90], Chang, Wang, and Chen (2017), and Johnson, et al. [32] argued that some diagnostic tests are inaccurate in their results and are lacking in specifying whether TB is latent or active Chang, et al. (2017), [90,32]. Consequently, the physicians and other health care providers are required to be careful in interpreting the test results of their TB patients Chang, et al. Chang, et al. 2017, [90,32]

Testing whether TB is latent or active in patients is important for the successful treatment of TB patients. To investigate the latent state of TB, some physicians often chose the tuberculin skin test (TST) or Gold In-Tube Test (QFT-G) release assay (IGRA) using the blood specimen of their patients to ascertain if TB is latent in their patients [86,32,91]. However, disparity does exist in the efficacy of these diagnostic tests.

The Gold In-Tube Test (QFT-G) release assay (IGRA) is a more effective diagnostic test than its counterpart TST. Ahmadinejad, et al. [86], Kim, et al. [87] and Niguse, et al. [88] argued that the TST is well known for yielding false positive and false negative results of a TB diagnostic test. Conversely, the QFT is more likely than the TST to reveal an accurate result of a TB diagnostic test [86,87,88]. Despite the challenges associated with TST and Gold In- Tube Test (QFT-G) release assay (IGRA), the detection of the latent state of TB is possible through a chest X-ray exam.

Effective diagnoses of latent TB are associated with an X-ray exam, besides the TST and QFT diagnostic tests. Ahmadinejad, et al. [86] and Johnson, et al. [32] explained that when a positive result of TST or QFT is associated with a negative chest X-ray, this has indicated that TB is latent. Hence, the diagnosis of latent TB has required the good judgment of some physicians and other health care providers in selecting a relevant diagnostic test for an accurate result of a TB diagnosis.

Examining patients for active TB has required an advanced level of testing.

Previous studies indicated that health care providers often utilized acid-fast bacilli in the sputum of suspected TB patients to detect this infectious disease through the smear microscopy test [92,32,88] Such a testing technique has been found to be cost-effective and useful in detecting the acid-fast bacilli and confirming whether TB is active in some patients [92,93,32]. Despite its advantages, many researchers have recommended the use of other diagnostic tests over the smear microscopy for testing active TB in patients.

The Xpert MTB/RIF or GeneXpert) molecular test is more effective than the smear microscopy test. Desikan [94], Law, et al. [95], and Shuaib, et al. (2018) argued that despite its widespread use in diagnosing TB, the smear microscopy test is limited to establishing the dissimilarity between the smears of *Mycobacterium tuberculosis* and non-tuberculosis *Mycobacterium*. Furthermore, this testing technique regularly confounded the acid-fast bacilli positive smears for negative acid-fast bacilli Shuaib, et al. (2018) [94,95]. Additionally, it has been found to be less effective in specifying or detecting the sensitivity of the *Mycobacterium tuberculosis* species Shuaib, et al. (2018) [94,95] Contrarily, the Xpert MTB/RIF diagnostic test has proven to be a more rapid and accurate test than its counterpart smear microscopy in differentiating the smears of *Mycobacterium tuberculosis* and nontuberculous bacteria [94,95] Shuaib, et al. 2018. However, there has been criticism associated with the Xpert MTB/RIF diagnostic test.

The Xpert MTB/RIF diagnostic test is expensive. Despite being more efficient than the smear microscopy test, the cost of the Xpert MTB/RIF test oftentimes limited its use in most low-income and poor countries of the world Shuaib, et al. (2018) [94,95] Both the Xpert MTB/RIF and smear microscopy tests are highly recommended for diagnosing TB. However, there are other advanced diagnostic tests required for examining patients, suspected with TB.

Newer assays are available for detecting the multiple and extensively drug- resistant *Mycobacterium tuberculosis*. Desikan [94] and Lavania, et al. [96] argued that the DNA amplification and oligonucleotide probe hybridization, Line Probe Assay (LPA), and multiple drug-resistant TB (MTBDR) are viable diagnostic tools for detecting multiple drug-resistant in some TB patients. After diagnosing patients with TB, the health care providers have prescribed appropriate drug regimens to treat their TB patients.

Treatments for tuberculosis

TB is curable. The CDC (2017) [50], Jinbo, Lustik, West, and Kloetzel [97], and Johnson, et al. [32], noted that the isoniazid therapy is commonly used to treat patients, with the latent TB. However, some health care providers have often recommended a different dose of this treatment for different types of TB patients. Isoniazid therapy is required daily for nine months in HIV infected patients, children up to 11 years old, and twice a day with pyridoxine/vitamin B6 in pregnant women, with TB (Table 1) [50,97]. However, the Isoniazid therapy and Rifapentine are recommended once a week for three months in latent TB patients, aged 12 and older (Table 1) [98,50,97,32] The treatments for patients with active tuberculosis are different.

The treatment regimen for patients, with active TB, is a combination of several drugs. The CDC (2017) [50] and Johnson, et al. [32] argued that patients, who diagnosed with negative culture for the *Bacillus bacterium,* are recommended to take the isoniazid therapy, rifampicin, ethambutol, pyrazinamide, and ethambutol regimen once daily for at least three months. Conversely, those, who diagnosed with a positive culture for *Bacillus bacterium*, are administered with the Isoniazid and

rifampicin drug treatments for 18 weeks [98,32]. A theory is a concept of philosophizing on an event based on existing data.

The epidemiological triad theory and its applicability in previous tuberculosis research

The epidemiological triad theory is used as a guide for this research on tuberculosis in New York-Newark-Jersey City. Such a philosophy was first speculated in the nineteenth century and developed by Wade Hampton Frost into a full theory beginning in the twentieth century [99,29]. The epidemiological triad theory has suggested that the incidence of an infectious disease is often based on the interactions of a causative agent, host, and environmental factors in a given population [28,100,29]. The causative agent, however, maybe a microorganism or virus, which has caused an infectious disease in the hosts [28,100,29]. These hosts may be human beings or animals in which the causative agent has caused the infectious disease [28,100,29]. The host-pathogen is the primary interaction in the development of an infectious disease in an environment.

Investigating the environmental risk factors that prompted the incidence of an infectious in a population is important. The environmental risk factors were the social circumstances, which have often exposed some persons to an infectious disease in a given population [28,100,29]. Consequently, informing about the lifestyle of a study population is also crucial for researchers in investigating the incidence of an infectious disease in a given population. As such, research indicated that having educated on the host-pathogen interaction is crucial for researchers to discover the risk factors for the occurrence of an infectious disease in a given population [28,100,29]. Adopting the epidemiological triad theory, this study explored the relationship between the *Mycobacterium tuberculosis* species, human host, and environmental risk factors that elicited the incidence of TB from 1993 to 2017 in New York-Newark-Jersey City.

For the host-pathogen interaction to exist, the *Mycobacterium tuberculosis* must have produced some types of biomarkers to infect the cell of its hosts. Many researchers indicated that the type VII- ESX protein secretion system is such biomolecule upon which the *Mycobacterium tuberculosis* has relied for transportation of proteins through the immune system of a host [101,102,103]. Furthermore, such a biomarker (e.g., type VII-ESX protein system) has been found in previous studies to play a crucial role in obliterating the alveolar cell causing TB in the lungs of such a host [101,102,103]. However, other researchers thought that the cyclic AMP has mostly used by *Mycobacterium tuberculosis* to modify the cell of its hosts.

The cyclic AMP has frequently involved in the host-pathogen interaction of *Mycobacterium tuberculosis*. Previous studies found that the cyclic AMP is a protein regulator molecule, which is often seen in the host-pathogen interaction within the immune system of an infected host [104,105,106]. However, research also indicated that the primary role of the cyclic AMP is to control the expressions of genes within the *Mycobacterium tuberculosis* species during while causing TB inside the lungs of such a host [104,105,106]. The host- pathogen interaction has occurred by the influence of some environmental factors in a given population.

The epidemiological triad theorist has encouraged researchers to investigate the relationship between an infectious agent and environmental risk factors. The CDC (2012) [28] and James [100] noted that various environmental risk factors, such as biological, socioeconomic, and healthcare inequality are common determinants for the incidence of an infectious disease in a population. Additionally, the age, sex (gender), and behavior of some patients often influenced their exposures to the *Mycobacterium tuberculosis* species in an environment [28,100,107]. These risk factors are also known as the socioeconomic circumstances that have elicited the transmission of TB from person to person in a population.

The socioeconomic status is a risk factor for TB transmission worldwide. Likewise, Migliori and Garcia-Basteiro [108] and Petrol, et al. (2017) argued that poverty is the primary indicator of the global TB incidence trends for past the past decade. However, unemployment and poor housing were the most frequent risk factors being observed for the global TB incident cases from 2014 to 2018 Petrol, et al. (2017) [108]. Thus, the socioeconomic status of some persons has represented a burden for the global elimination of TB.

The eradication of TB must have approached from a socioeconomic perspective. Previous studies found that the cost associated with caring for TB patients is exorbitant Pedrazzoli, et al. (2017), [108,109]. Such an economic issue often led to low adherence, discontinuation of TB care, and unsuccessful treatments among some TB patients across the globe Pedrazzoli, et al. (2017) [108,109]. The high cost of TB care and treatments is a challenge for eradicating TB worldwide.

The low economic status is problematic in attempting to eliminate TB, globally. Migliori and Garcia-Basteiro [108], Pedrazzoli, et al. (2017), and Wingfield, et al. [109] argued that unless alleviating the financial burden among the poor, the global elimination of TB may not be possible. Moreover, research indicated that eradicating TB is possible by implementing an intervention focusing on reducing the social challenges associated with poor TB patients in accessing the quality of care and treatments for their TB disease Pedrazzoli, et al., 2017; [108,109].

Understanding the social barriers connected to the dissemination of TB is also important for the global elimination of this infectious disease. Addressing the social challenges in attempting to eradicate TB is imperative for an effective global TB intervention. From this perspective, Migliori and Garcia-Basteiro [108], Pedrazzoli, et al. (2017), and Wingfield, et al. [109] thought that such a social initiative is crucial for preventing the multi-drug resistant, poor clinical adherence, inaccessibility to TB care among the poor TB patients worldwide. The epidemiological triad theorist has also suggested researchers investigate the biological risk factors in relation to the incidence of an infectious disease in a given population.

From a biological perspective, the *Mycobacterium tuberculosis* agent has prevented the efficacy of some TB drug treatments in some patients. Such an ideology supported by Bento, Empadinhas, and Mendes [110], Esterhuyse, et al. [111], and Singh, Garg, Rath, and Goyal [112] in arguing that the host-bacillus interaction is regularly associated with some unsuccessful cases of TB treatments in immunocompromised, elder, and drug-susceptible TB patients. Further, Fukui, et al. [113], O'Shea and McShane [114], and Weiner and Kaufmann [115] argued that the disruption of the macrophage cells by *Mycobacterium tuberculosis or Bovis* is often times associated with the ineffectiveness of the Bacillus Calmette-Guerin vaccine and other TB therapeutic drug treatments in some TB patients. The *Mycobacterium tuberculosis* has also averted the effect of some treatments in TB patients, with imbalance liver enzymes.

Drug-Induced liver injury is a common complication in TB treatments. Such a condition often influenced an increased level of the liver enzyme or injury in the liver of some TB patients [116,117,118]. In many instances, the liver disease or injury resulted in the susceptibility of some patients to the Isoniazid and other TB drug treatments for their TB disease [116,117,118]. Often, the complication of drug-induced injury has resulted in poor TB outcomes in some patients.

Drug-Induced liver injury is fatal to some TB patients. In their studies, Abbara et al. [116], Naidoo, et al. [117], Tweed, et al. [118], and von Braun, et al. [119] stated that the most unsuccessful TB treatment cases often resulted in a deterioration of health and high mortality rate of some TB patients, with a liver disease. Also, the fatality of the TB drug-induced liver injury frequently associated with the alcohol abuse, liver disease, and co-HIV patients at an advanced stage of the TB disease [116,117,118,119]. Most of the drug-induced liver injury cases associated with TB patients, aged 35 and older [116,117,118]. Other than the biological risk factors, the behaviors of some patients have played an integral role in the dissemination of tuberculosis worldwide.

Evidence has shown that the behavioral risk factors of some patients have associated with their exposures to the contagious *Mycobacterium tuberculosis* species. The epidemiological triad theorist has encouraged researchers to investigate the behaviors of patients in relation to the incidence of infectious diseases, such as tuberculosis in a given population [28,100]. The behavioral risk factors for transmitting TB from person to person in a population are various. Similarly, the sharing of space, items, failed adherence to TB care and treatments, and consumption of alcohol have been found as the associated risk factors for transmitting TB from person to person in an environment Prado, et al. (2017), [120,121,8]. Also, the epidemiological triad theorist has suggested researchers to investigate whether the age and gender of patients are influential risk factors for the occurrence of an infectious disease in a population.

The age and sex demographics are inherent risk factors for the transmission of TB in a given population. As such, they played influential roles in the global incidence of TB in several communities across the globe from 2010 to 2017 [28,100,29]. During a TB investigation, many researchers often focused their studies on the age and gender of persons to investigate the incidence and mortality risks of TB in an environment [100,29,107]. Speaking of the age risk factor, children, aged 17 and under were vulnerable to acquiring latent TB for the past five years, worldwide [122,123,124]. Age is a risk factor for mortality among TB patients.

Estimating the average age for the mortality risk of TB is a challenge. Previous studies indicated that the global elderly population is disproportionately affected by the mortality of TB [125,126,29]. Conversely, Hannah, Miramontes, and Gandhi [127] and Zwerling, et al. [107] argued that such an obstacle to TB is more common among children and young adult TB patients than their elderly counterparts. Other than age, the epidemiological triad theorist has suggested that researchers understand the differences in gender of patients during the investigation of an infectious disease in a population.

Gender or sex (gender) is an influential risk factor for TB transmission worldwide. Feng, et al. [128] and Yates and Atkinson [129] argued that men are more likely than women to be diagnosed with TB. However, such a disparity in the diagnoses of TB is often seen among TB patients, with social, cultural, and economic hardships across the globe [128,130,131]. As such, the low socioeconomic status represented a barrier for some women in accessing the quality of care and treatments for their TB disease during the 2010-2017TB incident cases worldwide [128,131,130]. Conversely, Horton, MacPherson, Houben, White, and Corbett [132], Oshi, et al. [131], and Yates and Atkinson [129] taught that the indoor air pollution and HIV infection were the most frequent risk factors for transmitting TB among

women in worldwide. Unlike women, some men have experienced different risk exposures for acquiring and developing TB.

The social lifestyle of some men has provoked their exposure to TB. Horton, et al. [132], Jankowska-Polanska, et al. [130], and Oshi, et al. [131], and Yates and Atkinson [129] argued that unemployment, alcohol consumption, inadequate education, and loneliness are globally associated with the lack and non-adherence to TB care and treatments among some men. Specifically, the financial burden of some men often prevented them from obtaining the quality of care and treatments recommended for curing their TB disease [132,130,131,129]. The epidemiological triad theorist has defined a human host as the reservoir of an infectious agent; however, humans are diversified in race and ethnicity.

The race/ethnicity demographic is frequently investigated in the epidemiological studies of tuberculosis. The individuals' race/ethnicity regularly influenced the incidence of TB in the United States [10,133,134]. However, the socioeconomic status of non-Hispanic Asian, Black, and Hispanic, and White TB patients often determined their attributions in the incidence of TB for the past 25 years in the United States [10,133,134]. Despite the racial and ethnic disparity among TB patients, they had similar experiences in diagnosing for the disease across the globe, including the United States.

The inaccuracy in TB diagnoses is associated with some unsuccessful TB treatment cases across the globe. Researchers indicated that such a delay in TB diagnoses is connected to the false positive or false negative results of some patients testing for TB in the United States and abroad [87,135,134]. Globally, the inaccuracy in TB diagnoses often affected the judgment of some physicians and other health care providers in prescribing the unneeded or unnecessary drug regimens to some of their TB patients [135]. Such inaccuracy in results of some TB exams associated with the interruption of treatments and the death of many TB patients across the globe [136,135,134]. Despite its association in the research of TB, the race/ethnicity variable has not been emphasized in the epidemiological triad theory.

The race/ethnicity demographic has an influence on the global transmission of tuberculosis. Consequently, the inclusion of race/ethnicity as a risk factor for investigating an infectious disease, such as TB in a given population, is highly recommended to enhance the epidemiological triad theory. Despite its lack of emphasis on race/ethnicity, this theory has clearly shown the connection of an infectious agent, host, and environmental risk factors in provoking the incidence of an infectious disease in a population. The epidemiological triad theory is appropriate for this TB research in New York- Newark-Jersey City. Using this theory, researchers often learned about the interactions of an infectious agent, host, and environmental risk factors while investigating an infectious disease in an environment [28,100]. Similarly, the epidemiological triad theory played is feasible for exploring the relationship between the non-Hispanic Asian, non-Hispanic Black, Hispanic, non-Hispanic White, and multiracial TB patients from 1993 to 2017 from this area in New York City. Thus, race/ethnicity, age, and sex (gender) demographics are considered as the intrinsic risk factors for the incidence of an infectious disease in a given population.

Race/ethnicity, age, and gender have regularly influenced the incidence of TB in a given population. Thus, the hypotheses of this research are partially drawn on the race/ethnicity, age, and gender of persons as contributing predictors for the elevated TB incident rate from 1993 to 2017 in New York-Newark-Jersey City. However, the research gap for which the justification is needed is in whether inadequate TB therapy completion and susceptibility of some TB patients to Isoniazid and Rifampin associated with the high incident rate of TB during this period in New York-York-Newark Jersey City.

Related evidence on the escalation of tuberculosis incidence from 2011 to 2017 in New York-Newark-Jersey city

The race/ethnicity has an influence on the incidence trends of TB in New York- Newark-Jersey City. The illegal immigrant Hispanics, for instance, experienced inadequate health insurance and high cost of TB care, which have influenced the burden of TB in their community between 2015 and 2017 from this area in New York City [2,9,5]. Often, the illegal immigration status of some Hispanic TB patients associated with their ineligibility for receiving the quality of TB care and treatments for their TB disease in this region New York [2,9,5]. As a result, the lack of immigration status often associated with the unsuccessful TB treatments and elevated incident cases of TB among the Hispanics in New York City [2,9,5]. The escalation of TB incidence among people from this ethnic group in New York-Newark-Jersey City was also associated with their behaviors. The social lifestyle and other morbidities are contributing risk factors for the high burden of TB among the Hispanics in New York-Newark-Jersey City. Similarly, research indicated that alcohol consumption, substance, and illegal drug use are contributing risk factors for treatment complications and high incidence of TB among the Hispanics in this area of New York City [26,9,5].

Additionally, HIV and diabetes morbidities haven associated with the incidence of TB among the Hispanics in New York-Newark-Jersey City from 2015 to 2017 [9,5]. Similarly, the socioeconomic risk factor associated with the burden of TB within the non-Hispanic Black community in this metropolitan area of New York.

The socio-economic risk factor has immensely impacted the high burden of TB among the non-Hispanic Blacks in New York-Newark-Jersey City. Howley, et al. [137] and Katyal, et al. [26] indicated that incarceration, unemployment status, and substance use are related risk factors for TB transmission among the non-Hispanic Blacks in this part of New York. Additionally, Katyal, et al. [26], Knorr, et al. [1], and Marks, et al. [138] indicated that homelessness, smoking, and alcohol consumption are contributing risk factors for TB infection and treatment complications among persons of the above ethnic group in New York-Newark-Jersey City. Some preexisting health conditions, however, have been associated with TB among the non-Hispanic Blacks in this area of New York.

Both HIV and Diabetes are associated with risk factors for the burden of TB incidence among the Non-Hispanic Blacks in New York-Newark-Jersey City. From 2014 to 2018, HIV and Diabetes have been associated with the incident cases of TB among the non-Hispanic Blacks from this region in New York City [137,26,138]. Often, these morbidities associated with TB drug susceptibility and high mortality rate among the non-Hispanic Black TB patients in New York-Newark-Jersey City [138,139]. However, non- Hispanic Whites have experienced a low burden of TB in this part of New York.

The risk factor for acquiring TB among the non-Hispanic Whites in New York- Newark-Jersey City is controversial. In their studies, Howley, et al. [137], Sanderson, et al. (2015), Slutsker, et al. [8], and Pagaoa, et al. [140] argued that having contacts with an active TB patient is the primary risk factor for transmitting TB among the non- Hispanic Whites in New York-Newark-Jersey City. Conversely, the HIV risk factor is associated with the low burden of TB among the non-Hispanic White TB patients from this region of New York [139]. The misconception about TB is also a risk factor for acquiring the disease among non-Hispanic Whites. For instance, Howley, et al. [137] and Pagaoa, et al. [140] argued that the belief of some non-Hispanic Whites in having adequate TB knowledge to protect themselves from acquiring the disease is also a risk factor for TB transmission in New York-Newark-Jersey City. However, finding the risk factors for TB among non-Hispanic Asians is challenging in this area of New York.

The risk for a high burden of TB among non-Hispanic Asians is unclear in New York-Newark-Jersey City. The non-Hispanic Asians are classified among the top four ethnic groups of TB patients in this part of New York. However, their risk exposures to this infectious disease are currently unclear. Klein, Harris, Leone, and Pettifor [141] and Stennis, et al. [4] found the non-Hispanic Asian TB patients to have constantly refused to test for HIV, which is a common risk factor for TB in New York-Newark-Jersey City. Consequently, such a low adherence to HIV testing among the non-Hispanic Asians led Stennis, et al. [4] to say that HIV may be a contributing risk factor for the high burden of TB among the non-Hispanic Asians in this area of New York. Besides the race/ethnicity demographics, the gender difference is a contributing risk factor for the incidence trends of TB in this district of New York.

Gender differences also influenced the incidence of TB from 1993 to 2017 in New York-Newark-Jersey City. In their studies, Katyal, et al. [26] and Stennis, et al. [9] argued that the risks of unemployment, poverty, and co-HIV infection are associated with more female TB patients than their male counterparts from this region in New York. Similarly, Gounder, et al. [7] and Slutsker, et al. [8] indicated that the female children, aged five and under are disproportionately affected by the resurgent incidence of latent TB in this area of New York. Also, the age demographic has an influence on the high burden of TB in New York-Newark-Jersey City.

TB has affected persons of all ages in New York-Newark-Jersey City. However, identifying the most affected age group of TB patients has remained a controversial topic in this area of New York City. From 2014 to 2017, children, aged five and under were more vulnerable than older adults to acquiring the TB infection through contact with TB patients in poor housings and communities in New York-Newark-Jersey City Sanderson, et al. (2015) [7,8]. Conversely, TB patients, aged between 19 and 50 were more at risk of infecting with TB at work, schools, and by interacting with other persons in New York-Newark-Jersey City Robbins, Shashkina, Kreiswirth, & Proops, (2017) [137,4].

Other researchers argued that the elderly community is disproportionately affected by the incidence of TB in New York-Newark-Jersey City. The New York City Department of Health and Mental Hygiene (2017) and Marks, et al. (2014) [3] argued that older persons, aged 65 and older are mostly afflicted by TB from this region of New York City. Additionally, the elderly population has been afflicted by the multi-drug resistant and mortality issues from this area in New York City New York City Department of Health and Mental Hygiene (2017) [3]. The individuals' race/ethnicity, age, and sex (gender) had influenced the escalation of TB incidence during these past five years in New York-Newark-Jersey City.

Summary

The purpose of the review in Chapter 2 was to discuss the evidence related to the incidence of TB for the past five years in New York-Newark-Jersey City. However, this review focused mainly on finding the evidence related to the individuals' race/ethnicity, age, sex (gender), issues of therapy completion and drug susceptibility, and the TB incident cases between 1993 and 2017 from this area in New York City.

Previous studies showed the relevance of gender

and race/ethnicity demographics to the elevated incident cases of TB in New York-Newark-Jersey City during 1993-2017. However, the findings of these studies showed that the age demographic was the most influential risk factor for exposing persons to TB from this region in New York City.

Importantly, the literature gap of this review was based on the relationship between TB therapy completion, isoniazid and rifampin susceptibility, and the high TB incident cases from this metropolitan area in New York. From a retrospective cohort study design, this quantitative analysis study was conducted on the relationship between the individuals' demographic characteristics, issues connected to TB therapy and drug susceptibility, and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

Chapter 3: Research Method

Introduction

The purpose of this quantitative study was to explore the relationship between demographic characteristics of TB patients, therapy completion, isoniazid and rifampin susceptibility, and the TB incident cases between 1993 and 2017 in New York-Newark- Jersey City. Age, sex (gender), race/ethnicity, completion of therapy within one year, and testing for isoniazid and rifampin susceptibility were the independent variables for this study. The TB incident cases between 1993 and 2017 from this area in New York City was the dependent variable for this research. Chapter 3 consists of the rationale for conducting this TB research, methodology, threats to the validity of this study, and a summary section.

Research design and rationale

This study was a quantitative analysis with a focus on a retrospective cohort design. MacGill (2018) and Sedgwick (2014), and Setia [142] indicated that a cohort study may be designed as prospective or retrospective. Prospective or retrospective designs were previously used in research to investigate the risk factors of a given outcome during a long period of time in a large population MacGill, (2018), Sedgwick, (2014) [142]. Using the retrospective cohort study design allowed me to investigate whether race/ethnicity, age, sex (gender), completion of TB therapy within one year or less, cases tested for susceptibility to isoniazid and rifampin were associated with the elevated TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

Both prospective and retrospective cohort study designs are crucial in evaluating whether one or more variables are related to an event of interest.

The retrospective cohort design differs from a prospective design. A prospective cohort study design is of value in conducting research from a population-based approach to investigate the risk exposures for a particular outcome MacGill, (2018), Sedgwick, (2014), Setia [142] argued that. In contrast, the retrospective cohort study is often used to investigate whether a set of existing data is related to such an outcome in a given population MacGill, 2018, Sedgwick, (2014), [142]. Furthermore, a cohort study design is critically important in investigating the increasing incidence rate of an event at a specific location [142]. As such, the retrospective study design was appropriate for investigating if race/ethnicity and covariates, age and sex (gender), completion of therapy within one year, and testing for isoniazid and rifampin susceptibility were predictors of the TB incident cases in New York-Newark-Jersey City from 1993 to 2017.

There are disparities in time and cost for conducting a prospective or retrospective cohort study. The cost of conducting a prospective cohort study is exorbitant and requires a long time to complete MacGill, (2018), Sedgwick, (2014) [142]. Contrarily, using a retrospective study design was cost-efficient in previous studies, and required a shorter time for analyzing a secondary dataset of an event from a population Sedgwick, 2014 [142]. This study was a quantitative analysis and was not subjected to time constraints and high costs of using a prospective cohort study design.

Using the retrospective cohort design strengthened the potential of this study for advancing the knowledge in the TB research discipline. MacGill (2018) thought that a retrospective study design is the finest method to be used for conducting medical research involving the investigation of several predictors of an outcome in a given population.

Such a study design was previously used in both the non-experimental and experimental research studies for investigating numerous risk factors in relation to one outcome at a specific location MacGill, (2018), Sedgwick, (2014), [142]. Additionally, the cohort study design was previously credited for its effectiveness in conducting research within a large population MacGill, (2018), Sedgwick, (2014), [142]. Thus, the retrospective cohort study design was feasible for investigating the relationship between the individuals' race/ethnicity, age, and sex (gender), and issues of therapy completion and drug susceptibility in New York-Newark-Jersey City from 1993 to 2017. Also, a retrospective cohort design is crucial for studies involving the evaluation of variables of different scales of measurements.

Methodology

Study population: This study is representative of the population of TB patients between 1993 and 2017 in New York-Newark-Jersey City. However, the disease population is subdivided into the non-Hispanic American Indians or Alaskans Native, non-Hispanic Asians, non- Hispanic Blacks, Hispanics, non-Hispanic Whites, and multiracial TB patients. To obtain data for

this study, the publicly available 1993-2017 TB dataset was used from the CDC's online tuberculosis information system (OTIS). Prior to obtaining the above TB dataset, a request was made to the institutional review board (IRB) of Walden University about granting an exemption of ethical approval to access the data. Upon receiving the permission from this institution (IRB number: 10-08-19- 0399079), the data for the independent variables, race/ethnicity, age, sex (gender), completion of therapy within one year, and testing for isoniazid and rifampin susceptibility were obtained, as well as the dependent variable, cases of 672 TB cases from 1993-2017 in New York-Newark-Jersey City. Notably, the CDC is reputed for availing trustworthy public health data and information for other researchers to conduct their own studies. Thus, the data obtained from the 1993-2017 TB dataset from this agency was considered safe. The generalizability of this research was also based on the demographic characteristics of its study population.

Both age and sex (gender) are known as the intrinsic risk factors for the incidence of TB in a given population. However, the persons of a certain age and gender groups were disproportionally affected by the incident cases of TB from 2011 to 2017 in New York-Newark-Jersey City. Hence, in part, the purpose of this study was to investigate whether age and sex (gender) demographics were predictors of the elevated TB incident cases between 1993 and 2017 from this area in New York City. For that reason, I included TB patients between the ages of 0-65 years and older, as they were reported in the OTIS database. Additionally, estimating the sample size was equally important for this TB research.

Estimation of sample size: The sample size for this study was estimated using the G*Power statistical analysis. Of this power analysis, there are several statistical tests available for the statistical analyses of social, behavioral, and biomedical research studies [143]. However, the z-tests and Poisson regression models were selected for estimating the sample size, alpha, power, and effect size of this study. The alpha level from the G*Power analysis was set to 0.05, allowing for a 5% probability of error or type I error estimating the statistical values of this study.

Using the z-tests and Poisson regression model of the G*Power analysis, an estimated sample size (N = 128), along with the effect size of 0.8 and the actual power of 0.95 was suggested for conducting this study. Contrarily, the population of the TB disease between 1993 and 2017 in New York-Newark-Jersey City was estimated to 672 patients [43]. If an estimated sample (N = 128) could result in an effect size of 0.8, the sample size (N = 672) would be adequate to conduct this study. The Poisson regression model could be of value in analyzing the data of this study.

Statistical analytic method: The dependent variable of a research study often informs the appropriate statistical test for its analysis. Htway (n.d.) [144] and Jackson, (2016) indicated that the dependent variable of a study is the determinant of the types of statistic tests required for the data analysis of such a project. As such, the reported TB incident cases as the dependent variable of this study were an indicator that the Poisson regression model could be appropriate for analyzing this data. However, the Poisson regression model has various assumptions.

Like many other statistical tests, the Poison regression model has its own assumptions. Such a statistic test assumes the dependent variable of a research study is continuous and contains counted data [145,146]. As such, the dependent variable, reported TB cases, is a continuous variable with counted data.

Conversely, the independent variables of a Poisson analysis may be varied in categorical, continuous, or interval ratio variables [145,146]. The independent variables of this research were of different scales of measurements.

Of this study, the independent variables were mixed with the categorical variables, race/ethnicity, and sex and continuous variables, completion of therapy within one year, testing for isoniazid and rifampicin susceptibility, and age. Grande (2015) [147], Laerd Statistics (n.d.) [145], UCLA, Institute for Digital Research & Education (n.d.) [146], and Zed- statistics (2017) [148] indicated that the Poisson regression model has required the independent observation across the predictors of an outcome at a given time. Moreover, the mean and variance of the Poisson distribution must be similar [147,145,148]. It is worthwhile noting that, the threats to the validity of this research are minimal.

Threats to validity: The threats to the validity of a research study often determine the generalizability of findings in such a study. Featherston [149] and Froehlich [150] indicated that the threats to the validity of a study are often based on internal or external sources. From this study, the threats to the validity of its findings could come from external sources.

However, such threats were minimal because the 1993-2017 TB dataset has been collected and organized by the CDC agency in 2018.

As previously indicated, the CDC agency is trustworthy, with a great reputation in collecting health data for public use. Thus, obtaining the above dataset of the CDC's website assured a minimal external threat to the validity of findings from this study.

Importantly, this research was not associated with internal validity threats. Featherston [149] and Froehlich [150] also indicated that such threats are often associated with instrumentation, history, maturation, and selection bias of a prospective research study. Since this study was conducted from a quantitative approach, its findings could not be subjected to internal validity threats.

As indicated above, the usage of instrumentation is appropriate in a qualitative research study. However, this study was a quantitative analysis of a secondary dataset, and thus, was exempt from using instrumentation. Consequently, the threats associated with using the instrumentation could not affect the validity of findings from this TB research in New York-Newark-Jersey City.

Ethical concerns and data collection: To use an archival dataset, researchers must provide information on how they were collected. As such, the CDC (2018) [43] indicated that the 1993-2017 TB dataset is a combination of data from TB patients reported by the departments of health from the district of Columbia and Puerto Rico of the United States [43]. Upon receiving the data of TB patients from these health agencies, the CDC organized them into 28 variables [43]. Additionally, this agency has regularly updated and availed these data on a yearly basis for public use [43]. However, researchers are required to be ethical in collecting and using data for their studies.

Often, researchers are subjected to unethical research behaviors collecting and using data in their studies. Likewise, using the 1993-2017 TB dataset for the population of TB patients in New York-Newark-Jersey City did not exempt me from such an unethical threat. However, such a threat was minimal because I was not involved in collecting data of TB patients during this period. As previously indicated, I was obligated by the IRB of Walden University to ask for permission to access the 1993-2017 TB data set. Thus, I requested permission from the IRB of the above institution, and I was granted the opportunity to obtain this data set from the OTIS database of the CDC agency.

Using the information study participants for other purposes than what they were collected for is an unethical research practice. Such behavior of some researchers may be seen in using the information of their study participants for reasons other than what they purported to be used for (United States Department of Health and Services, n.d.) [151]. This unethical research practice may be observed in collecting data from human subjects in either an intervention or an observational study in which the researchers violate the privacy of their study participants [151]. However, I used the existing 1993-2017 TB dataset solely for the purpose of completing my dissertation research at Walden University. Additionally, some researchers may be subjected to unethical behavior in publishing the findings from their studies.

Exposing sensitive information of study participants to the public without their consent is another form of unethical research practice. Often, such behavior of some researchers is seen in publishing the names, medical records, and date of births of their study participants without informing them [151]. However, the above sensitive information of TB patients in New York- Newark-Jersey City was not included in the 193-2017 TB dataset, and thus, was not included in the data analysis of this study. Therefore, the publication of this dissertation research will not contain the sensitive information of TB patients listed above.

Summary

The purpose of this study was to investigate the relationship between demographic characteristics of TB patients, issues of TB therapy completion and drug susceptibility, and the TB incident cases between 1993 and 2017 in New York-Newark- Jersey City. As previously indicated, this quantitative analysis was based on a retrospective cohort study design. Chapter three of the dissertation provided the evidence showing the applicability of the retrospective cohort study design investigating several risk factors of an outcome of interest in a population for a long period of time. As such, this study design was appropriate in exploring the relationship between the individuals' race/ethnicity, age, sex, and issues of therapy completion and isoniazid and rifampin susceptibility, and the TB incident cases in New York-Newark-Jersey City from 1993 to 2017.

In Chapter 3, I presented the rationale for conducting this study. Additionally, it was included evidence on the feasibility of the Poisson regression model for analyzing the data of this study. Furthermore, I provided a section wherein the explanation about the minimal external threats of this study was provided. Additionally, Chapter 3 included a description of the procedure under which the 1993-2017 TB data set was obtained from the CDC agency.

Chapter 4: Study Results

Introduction

The purpose of this study was to investigate whether race/ethnicity, age, sex (gender), completion of therapy within one year, and testing for isoniazid and rifampin susceptibility were predictors of the TB incident cases in New York-Newark-Jersey City from 1993 to 2017. These variables were used to formulate the research questions and hypotheses of this study. A reasonable research question and hypothesis is one that attempts to identify the population of a research study Farrugia, Petrisor, Farrokhyar, & Bhandari (2010). As such, the research questions and hypotheses from this research were formulated by questioning whether the individuals' race/ethnicity, age, and sex (gender) were associated with the incident cases of TB in New York-Newark-Jersey City during 1993-2017.

This study was also conducted by formulating other research questions and hypotheses, which interrogated whether the issues of therapy completion and isoniazid and rifampin susceptibility were predictors of the TB incident cases between 1993 and 2017 from this region in New York City. These research questions

and hypotheses were formulated to investigate the incidence of TB between 1993 and 1997 in New York-Newark-Jersey City.

*RQ*1. Is there a relationship between race/ethnicity and covariates (age and sex), and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City?

H0 1. There is no relationship between race/ethnicity and covariates (age and sex), and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

H1 1. There is a relationship between race/ethnicity and covariates (age and sex), and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

*RQ*2. Is there a predictive relationship between the completion of therapy within one year and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City?

H0 2. There is no predictive relationship between the completion of therapy within one year and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

H1 2. There is a predictive between completion of therapy within one year and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

*RQ*3. Is there a predictive relationship between the cases that tested for isoniazid and rifampin susceptibility to the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City?

H0 3. There is no predictive relationship between the cases that tested for isoniazid and rifampin susceptibility to the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

H1 3. There is a predictive relationship between the cases that tested for isoniazid & rifampin susceptibility and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

In Chapter 4, I discuss the procedure required to obtain the 1993-2017 TB dataset. However, the main purpose of this chapter is to show the results, demonstrating whether the individuals' race/ethnicity, age, sex (gender), completion of therapy within one year, and testing for isoniazid and rifampicin susceptibility were predictors of the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. This study was conducted by using a secondary data set of TB representing this infectious disease's population in New York-Newark-Jersey City. In this chapter, I discuss the statistical results pertaining to the relationships between the independent and dependent variables of this study.

Data collection

This study was a quantitative analysis of a secondary dataset. Therefore, collecting data directly from TB patients in New York-Newark-Jersey City was not an option for this research. As such, this study was conducted by using data from the publicly available 1993-2017 TB dataset from the CDC's OTIS database. The TB data were organized for TB patients from the 50 states and metropolitan areas in the United States within the OTIS database (CDC, 2018). This database is a subsidiary site of the wide-ranging data online for epidemiological research (WONDER) from which the information about the TB dataset was made available for the public use [43]. Therefore, using the data of TB patients from the TB data set exempted me from the discrepancies in collecting data directly from the TB patients in New York-Newark- Jersey City during 1993-2017.

Determining the arrangement of this data set was crucial for conducting this TB research. To learn about how these data were arranged, I explored the OTIS website, which informed me about the organization of the 1993-2017 TB data set for New York- Newark-Jersey City. From this website, I learned about the data of TB patients that were arranged by groups, such as the individuals' race/ethnicity, sex (gender), and age groups from 1993 to 2017 [43]. The OTIS database included a variety of risk factors, disease criteria, and issues related to the incident cases of TB across the United States, including New York-Newark-Jersey City [43]. The OTIS database contained the variables that I was interested in for this study.

From the OTIS database, I obtained the independent variables, race/ethnicity, age, sex (gender), completion of therapy within one year, testing for isoniazid and rifampicin susceptibility, and cases of TB from 1993-2017 in New York-Newark-Jersey City. Prior to accessing the 1993-2017 TB data set, CDC agency I contacted asking for its permission to use the TB data set for this research. In response, a member of this agency replied by informing that the 1993-2017 TB dataset was and continued to be available for the public use. Therefore, I accessed this data set and obtained data regarding the independent and dependent variables of this study. However, I was concerned that using this data set might harm the validity of this data due to a minimal external threat issue.

External validity threats can efface the generalizability of a quantitative research study. More specifically, external threats represent a challenge in interpreting the findings of a quantitative research study [149,150,152]. Such threats are often associated with selecting the participants of a study based on the individuals' race/ethnicity, which is a selection bias [149,150]. Consequently, the generalizability of findings

from this study may not be representative of its study population [149,150].

In this study, the sample included individuals of all ethnic backgrounds, including American Indian, Asian, Black, Hispanic, Multi-racial, Native Hawaiian, and White TB patients between 1993 and 2017 in New York-Newark-Jersey City. Consequently, the exclusion of study participants based on their race/ethnicity was not a threat to the generalizability of findings in this TB research. However, other demographic characteristics could represent a threat to the validity of a research study. In this study, both age and sex (gender) demographics were evaluated to prevent such a validity threat from affecting the generalizability of this study. Featherston [149] and Froehlich [150] argued that conducting a study with participants of a limited age or gender group may not be representative of some other age and sex (gender) groups of a study population.

However, such a selection bias was not associated with this study because its sample included both male and female TB patients, aged between 0-65 years and older in New York-Newark-Jersey City.

The size of the sample from a study may also represent a threat to its validity of findings. Froehlich [150] and Grande (2014) [152] indicated that the sample size of quantitative research can represent a burden for the validity of the findings of a study. However, such an external threat is often associated with a quantitative research study with an inadequate sample size to represent its population [150,152]. This study involved the investigation of 672 TB patients, and thus, was adequate to represent the population of the TB disease between 1993 and 2017 in New York- Newark-Jersey City.

The participants of this study accumulated an estimated 46,512 TB incident cases from 1993 to 2017 in New York-Newark-Jersey City. Of these cases, 27,926 cases completed therapy within one year or less, and 20,264 cases were associated with the issue of isoniazid and rifampin susceptibility during this period. Notably, these TB incident cases were ethnically subdivided among the American Indians, Asians, Blacks, Hispanics, Multi-racial, Native Hawaiians, Whites, and other unidentified ethnic groups in New York-Newark-Jersey City [43]. Also, analyzing the 1993-2017 TB data set required the creation of an SPSS data set.

Transfer of data into the IBM-SPSS, version 25

The data obtained from the OTIS database were entered into the SPSS version 25 using a password-protected computer for the safety of these data. Additionally, the newly created SPSS TB data set was saved into a flash drive and placed in a secured location.

As previously indicated, this study involved in predicting whether the individuals' race/ethnicity, age, and sex (gender), and completion of therapy within one year, and isoniazid and rifampin susceptibility were related to the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

Some of these predictors were string variables. However, the SPSS software would not analyze the data that were associated with these string variables. Consequently, the independent variable, such as completion of therapy within one year was converted into COT for the ease of data analysis on SPSS. Likewise, the tested for isoniazid and rifampin susceptibility variable was converted into TIRS allowing the SPSS software to analyze its data. However, some other demographic variables were not changed into acronyms from the OTIS database.

The age demographic has been reported as it was within the OTIS database, and thus, was entered as such into SPSS. The data of the sex variable, however, could not be analyzed using SPSS. Consequently, the sex (gender) demographic was changed into r@sex allowing for its data to be analyzed on SPSS. The race/ethnicity variable had not changed to an acronym in the OTIS database. However, the SPSS software could not analyze the data that were associated with the individuals' race/ethnicity.

The race/ethnicity variable was converted into race.eth_cat allowing the SPSS software to analyze its data. Additionally, the SPSS could not analyze the data of the reported TB incident cases, which was the dependent variable of this study. Therefore, this variable was changed into TBcases@1993.2017 easing the analysis using SPSS software. Notably, the SPSS software is accustomed to analyzing the numerical data. Therefore, the variables from this study were coded with various numerical values.

As previously indicated, the OTIS database had organized the data of TB patients by their ethnicities (e.g., American Indian or Alaska Native, non-Hispanic, Asian, non- Hispanic, Black or African American, non-Hispanic, Hispanic or Latino, Whites, non- Hispanic, multiple race, non-Hispanic, Native Hawaiian or Other Pacific Islander, non- Hispanic, and the not reported racial and ethnic groups). Using the SPSS software, the non-Hispanic White was coded as 0, non-Hispanic Black or African American was coded as 1, Hispanic or Latino was coded as 2, non-Hispanic Asian was coded as 3, non-Hispanic Multi-racial were coded as 4, Native Hawaiian or Other Pacific Islander, non- Hispanic was coded as 5, American Indian or Alaska Native, non-Hispanic was coded as 6, and the not reported race/ethnicity group was coded as 99. The individuals' age groups were also coded with some numerical values in this study.

From the OTIS database, the individuals' ages were organized into several groups, such as 0-4 years, 5-14 years, 15-24 years, 25-44 years, 45-64 years, 65 + years,

and not reported. However, when entered into the SPSS software, the 0-4 years group was coded as 1, 5-14years group was coded as 2, 15-24 years group was coded as 3, 25- 44 years group was coded as 4, 45-64years group was coded as 5, 65 + years group was coded as 6, and not reported age group was coded as 99. Likewise, the sex demographic was coded with some numerical values.

The TB incident cases were organized by the individuals' sex (gender) (e.g., male, female, or not reported sex) in the OTIS database. Therefore, when entered into the SPSS software, the male group was coded as 1, the female group was coded as 0, and the not reported sex group was coded as 99. Contrarily, the cases of therapy completion within one year and tested for isoniazid and rifampin susceptibility were coded differently in the OTIS database.

As previously indicated, the completion of therapy (COT) within one year was one of the string variables of this study. Importantly, this variable was used for measuring the numbers and percentages of TB incident cases that completed therapy within one year or less [43]. Therefore, the data of the COT cases were coded as no, yes, not reported, not applicable. Contrarily, when entered into the SPSS software, no was coded as 2, yes was coded as 1, not reported was coded as 99, and not applicable was coded as 999.

The CDC agency began organizing the TB incident cases, with isoniazid and rifampin susceptibility from 2005 to the present time in the OTIS database [43]. Additionally, this agency organized the incident cases, with susceptibility to isoniazid and rifampin as no, yes, not applicable. When entered into SPSS, the no cases were coded as 0, yes cases were coded as 1, and not applicable cases were coded as 999. Also, the missing data represented a challenge to analyze the data of this study.

There have been missing data reported in the 1993-2017 TB dataset. The missing values were associated with the tested for isoniazid and rifampin (TIRS) variable and were estimated to 168 incident cases. Likewise, an estimated 68 incident cases of TB have not been reported between 1993 and 2017 in New York-Newark-Jersey City. However, the not reported, not applicable, and missing data were treated similarly.

Both the independent and dependent variables of this study had contained either the not reported, not applicable, or missing data. Under the variable view of the created SPSS data set, the not reported and not applicable data were coded as 99 and 999, respectively. However, they have been treated as missing data while analyzing the variables they were associated with using the SPSS software.

From the OTIS database, the individuals' ages were organized into several groups, such as 0-4 years, 5-14 years, 15-24 years, 25-44 years, 45-64 years, 65 + years, and not reported. However, when entered into the SPSS software, the 0-4 years group was coded as 1, 5-14years group was coded as 2, 15-24 years group was coded as 3, 25- 44 years group was coded as 4, 45-64 years group was coded as 5, 65 + years group was coded as 6, and not reported age group was coded as 99. Likewise, the sex (gender) demographic was coded with some numerical values.

The TB incident cases were organized by the individuals' sex (gender) (e.g., male, female, or not reported sex) in the OTIS database. Therefore, when entered into the SPSS software, the male group was coded as 1, the female group was coded as 0, and the not reported sex group was coded as 99. Contrarily, the cases of therapy completion within one year and tested for isoniazid and rifampin susceptibility were coded differently in the OTIS database.

As previously indicated, the completion of therapy (COT) within one year was one of the string variables of this study. Importantly, this variable was used for measuring the numbers and percentages of TB incident cases that completed therapy within one year or less [43]. Therefore, the data of the COT cases were coded as no, yes, not reported, not applicable. Contrarily, when entered into the SPSS software, no was coded as 2, yes was coded as 1, not reported was coded as 99, and not applicable was coded as 999.

The CDC agency began organizing the TB incident cases, with isoniazid and rifampin susceptibility from 2005 to the present time in the OTIS database [43]. Additionally, this agency organized the incident cases, with susceptibility to isoniazid and rifampin as no, yes, not applicable. When entered into SPSS, the no cases were coded as 0, yes cases were coded as 1, and not applicable cases were coded as 999. Also, the missing data represented a challenge to analyze the data of this study.

There have been missing data reported in the 1993-2017 TB dataset. The missing values were associated with the tested for isoniazid and rifampin (TIRS) variable and were estimated to 168 incident cases. Likewise, an estimated 68 incident cases of TB have not been reported between 1993 and 2017 in New York-Newark-Jersey City. However, the not reported, not applicable, and missing data were treated similarly.

Both the independent and dependent variables of this study had contained either the not reported, not applicable, or missing data. Under the variable view of the created PSS data set, the not reported and not applicable data were coded as 99 and 999, respectively. However, they have been treated as missing data while analyzing the variables they were associated with using the SPSS software.

Data analysis and results

As proposed in the methodology section of this research, the Poisson regression model could be of value in the data analysis for this study. Therefore, this statistic test was utilized to analyze whether the race/ethnicity, age, and sex (gender) demographics, completion of therapy within one year, and testing for isoniazid and rifampin were predictors of the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

Prior to conducting this data analysis, the dependent variable (e.g., reported tuberculosis case) was tested for the equality of the mean and variance using the Poisson regression model. As part of the assumptions from this static test, the dependent variable of a research study must include counted data of which the mean and variance ought to be equal or similar [146]. However, Grace-Martin (n.d.) [153] indicated that such an assumption is commonly violated using the Poisson regression model. Therefore, the violation of equal statistical value between the mean and variance couldn't affect the results from the data analysis of this study.

Consequently, the Poisson regression model was used to individually analyze the variables from the three research questions of this study.

The Poisson regression was the best model for this quantitative analysis study.

The UCLA, Institute for Digital Research & Education (n.d.) [146] noted that the effectiveness of the Poisson regression is based on its provisions of the statistically significant p - values and the exponentiated coefficients showing a positive relationship between a predicting variable with outcome variable in a research study. The above static values could be of value in responding to the hypotheses of a research study.

As such, the above statistical values were used to decide about the hypotheses of this dissertation research. The UCLA, Institute for Digital Research & Education (n.d.) [146] also commented on these statistics by indicating that the coefficient and p-values of the Poisson regression analysis were often used in previous researches for deciding whether to accept or reject the null hypothesis in favor of the alternative one of a particular research question (UCLA, Institute for Digital Research & Education, n.d.) [146]. As such, the statistically significant p-values and exponentiated coefficients were crucial in showing the relationship between the individuals' race/ethnicity, age, sex (gender), issues of therapy completion and isoniazid and rifampin susceptibility, and the reported TB incident cases in New York-Newark-Jersey City from 1993 to 2017. Based on the results from the above analysis, the null hypotheses of this research were rejected in favor of the alternative hypotheses.

As previously indicated, the probability distribution is commonly violated in the Poisson regression model. As such in table 1, the descriptive statistics showed that the dependent variable reported tuberculosis cases violated this assumption. However, the Omnibus test of this analysis had shown the likelihood of all predicting variables to improve the Poisson regression model.

The Omnibus test is often seen as a gatekeeper by indicating the next step of the Poisson regression analysis. As such, it is critically important for investigating and revealing the likelihood of various predicting variables to improve the above model over the intercept (UCLA, Institute for Digital Research & Education, n.d.) [146]. Consequently, the race/ethnicity, age, sex (gender), COT, and TIRS predicting variables of this study were added into one model for testing their likelihood to improve the Poisson regression model. As a result, the Omnibus test of the Poisson regression analysis displayed a significant $p < 0.001$ indicating a statistically significant model. Therefore, the data analysis of this study proceeded by analyzing each of the above predicting variables against the outcome variable reported tuberculosis cases.

Research question 1 and hypotheses

The first research question of this study addressed the issue of whether race/ethnicity and covariates, age and sex (gender) were related to the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. Therefore, using the SPSS software, race/ethnicity, age, and sex (gender) were modeled as predictors of the response variable, reported TB incident cases using the Poisson regression test.

To analyze the above variables, the statistics feature of the generalized linear model was selected and yielded the following results in Table 2, Table 3, Table 4, Table 5, Table 6, Table 7, Table 8, Table 9. Also, it was worth noting that the Poisson regression model was useful in demonstrating the likelihood or probability distribution of data that were associated with the dependent variable, reported tuberculosis cases. Additionally, this model was also informative by showing the likelihood of the above-predicting variables to be analyzed against the dependent variable via the natural logarithm function. Thus, these findings bellow were integral in deciding whether to accept or reject the null hypothesis of research question number one.

In table 2, the Poisson regression model displayed the case processing summary of the reported

Table 2: The descriptive statistics showing the included and excluded tuberculosis incident cases from this study.

	N	Percent
Included	287	42.7%
Excluded	385	57.3%
Total	672	100.0%

Table 3: The descriptive statistics showing the distribution of tuberculosis incident cases across the individuals' race/ethnicity.

			N	Percent
Factor	Race/Ethnicity	American Indian or Alaska Native	43	15.0%
		Native Hawaiians	40	13.9%
		MULTR	31	10.8%
		Asians	42	14.6%
		Hispanics	47	16.4%
		Blacks	47	16.4%
		Whites	37	12.9%
		Total	287	100.0%

Table 4: The descriptive statistics about age, sex, and the reported tuberculosis incident cases.

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	Reported Tuberculosis Cases	287	.00	2417.00	160.1603	339.59037
Covariate	Reported Age in Years	287	1.00	6.00	3.5575	1.68996
	Reported Sex	287	.00	1.00	.4948	.50085

Table 5: Tests of model effects of race/ethnicity, age, and sex against the reported tuberculosis Cases.

	Type III		
Source	**Wald Chi-Square**	**df**	**Sig.**
(Intercept)	956.305	1	.000
Race/Ethnicity	5628.511	5	.000
Reported Age in Years	8245.448	1	.000
Reported Sex (gender)	2128.613	1	.000

Table 6: Parameter estimates showing the effects of the race/ethnicity, age, and sex (gender) variables on the reported tuberculosis cases using poisson regression model.

				95% Wald Confidence Interval for Exp(B)	
Parameter	**B**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
(Intercept)	3.583	.000	35.969	34.570	37.425
American Indian or Alaska Native, non-Hispanic	36.445[a]	.	1.487E-16	.000	.000
Native Hawaiian or Other Pacific Islander, non-Hispanic	- 6.771	.000	.001	.001	.003
Multi-racial, non-Hispanic	- 3.681	.000	.025	.021	.031
Asian, non-Hispanic	.610	.000	1.840	1.782	1.899
Hispanic or Latino	.739	.000	2.095	2.031	2.161
Black or African American, non- Hispanic	.891	.000	2.437	2.364	2.512
White, non-Hispanic	0b	.	1	.	.
Reported Age in Years	.277	.000	1.319	1.311	1.327
Reported Sex (gender)	.441	.000	1.555	1.526	1.584
(Scale)	1c				

tuberculosis cases. This table showed an estimated 672 TB incident cases that were reported between 1993 and 2017 in New York-Newark-Jersey City. Of these, 385 (57.3%) cases were excluded and 287 (42.7%) other cases were included in this analysis. Importantly, the excluded TB incident cases were determined based on the unreported, not applicable, and missing data in the OTIS database for New York- Newark-Jersey City from 1993 to 2017.

In table 3, the Poisson regression analysis showed the numbers and percentages of ethnic groups that were attributed to the incident cases of TB between 1993 and 2017 in New York-Newark-Jersey City. Additionally, this analysis showed that race/ethnicity risk factor was a categorical variable for the reported tuberculosis cases during this period.

This statistic test had also demonstrated the ethnic

distributions of TB among 287 patients from this area in New York City during this period above. Of 287 TB patients, there were 42 (14.6%) Asians, 47 (16.4%) Blacks, 47 (16.4%) Hispanics or Latinos, 31(10.8%) Multi-racial, 37 (12.9%) Whites, 40 (13. (%) Native Hawaiians, and 43 (15.0%)

American Indian or Alaskan Native in New York-Newark-Jersey City from 1993 to 2017.

In table 4, the Poisson regression model had treated both age and sex as the continuous variables of this research. Additionally, this statistic test had shown the distribution of data from the dependent variable were over dispersed. More importantly, this table contained descriptive statistics pertaining to the above continuous variables. From this analysis, there were 287 TB incident cases, along with a mean of 160.1603 and a standard deviation of 339.59037. Of these incident cases of TB, the individuals' average age was estimated to 3.5575, with a standard deviation of 1.68996. Despite treated as a continuous variable in this analysis, the individuals' sex (gender) was commonly known as a categorical variable. Therefore, interpreting the statistics associated with this variable was unnecessary.

From this analysis, the Omnibus test had demonstrated the likelihood of race/ethnicity, age, and sex or gender variables to improve the Poisson regression model, excluding the dependent variable of this study. Specifically, adding the above predicting variables to this model resulted in a $p < 0.001$ indicating a statistically significant model.

In table 5, the Poisson regression test had displayed the tests of model effects, with a statistically significant $p < 0.001$ indicating a positive relationship between the individuals' race/ethnicity, age, sex (gender), and the reported TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. In other words, this statistic test had revealed the overall effects of the above predictors on the incident cases of TB from this area in New York City during 1993-2017.

The analysis in table 6 was critical for responding to the hypotheses of research question one. In this analysis, the parameter estimates had displayed the statistically significant *p* - values and coefficients necessary for indicating whether the race/ethnicity, age, and sex variables were predictors of the dependent variable, reported tuberculosis cases in New York-Newark-Jersey City.

As previously indicated, the Poisson regression model had displayed the unstandardized coefficients "B", exponentiated coefficients "Exp(B), and *p*-values necessary to understand the relationship between the individuals' race/ethnicity, age, sex, and reported tuberculosis cases in New York-Newark-Jersey City from 1993 to 2017.

Often, researchers are relying on the resulting Exp (B) and p-values from the parameter estimate in Poisson regression analysis for deciding whether to accept or reject the null hypothesis of their research studies (The UCLA, Institute for Digital Research & Education, n.d.) [146]. As such, these statistical values must be used in deciding whether to accept or reject the null hypothesis in research question one.

Using Multi-racial as the reference category in table 7, the Poisson regression model displayed the ethnic distribution of TB among the American Indians or Alaskans, Asians, Blacks, Hispanics, Native Hawaiians, and Whites in New York-Newark-Jersey City from 1993 to 2017. In this analysis, the "Exp (B)" and p-values were considered for evaluating the effects of the above ethnic groups on the incident cases of TB from this region in New York City during this period.

From table 6, the Poisson regression analysis showed that Blacks, Hispanics, and Asians were approximately 2.4 (95% Cl, 2.364 to 2.512 $p < 0.001$), 2.1 (95% Cl, 2. 031to 2.161; $p < 0.001$), 1.8 (95% Cl, 1.782 to 1.899; $p < 0.001$) times more likely to be contributed to the incident cases of TB, respectively between 1993 and 2017 in New York-Newark-Jersey City. Additionally, the Multi-racial and Native Hawaiian ethnic groups were correspondingly 0.025 (95%Cl, 0.021 to 0. 031; $p < 0.001$) and 0.001 (95% CL, 0.001 to 0.003; $p < 0.001$) times as likely to contribute to the above incident cases of TB during this period in New York-Newark-Jersey City.

In this analysis, the individuals' age and sex (gender) were found to be 1.32 (95% Cl, 1.311 to 1.327; $p < 0.001$) and 1.56 (95% Cl, 1.526 to 1. 584; $p < 0.001$) times as likely to influence the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017. However, it was worthwhile knowing about which sex (gender) group was disproportionately affected by the above incident cases of TB from this area in New York City.

From table 7, the predicted log count of TB incident

Table 7: Parameter estimates showing males at a disadvantage in attributing to the reported tuberculosis cases.

				95% Wald Confidence Interval for Exp(B)	
Parameter	**B**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
(Intercept)	4.552	.000	94.864	93.493	96.255
Males	.460	.000	1.584	1.554	1.613
Females	0a	.	1	.	.
Scale	1b				

cases for males was estimated to 1.58 (95% Cl, 1.554 to 1.613, $p < 0.001$). This indicated that the male TB patients were 1.58 times more likely than their female counterparts to be infected with TB between 1993 and 2017 in New York-Newark-Jersey City.

In table 8, the Poisson regression model had shown the disparity in TB attributions among male and female patients in New York-Newark-Jersey City from 1993 to 2017. In this analysis, there were 188 (49.5%) male and 192 (50.5%) female contributors to the incident cases of TB from this area in New York City during this period.

Likewise, in table 9, the Poisson regression model had displayed the age distribution of the incident cases of TB between 1993 and 2017 in New York-Newark-Jersey City. With the age group 1 (e.g., 0-4 years) being considered as the reference category, the Poisson regression analysis had shown that the persons of all age groups, regardless of their ethnicities, were affected by the incident cases of TB during this period in New York-Newark-Jersey City. However, there was heterogeneity in the distribution of TB across the individuals' age groups between 1993 and 2017 from this area of New York City.

In table 9, the adult TB patients were afflicted by the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017. Looking at this table, it had shown that the age groups 4 (i.e., 25-44 years), 5 (i.e., 45-64 years), 6 (i.e., 65 = years), 3 (i.e., 15-24 years) were 14.58 (95% Cl, 13.746 to 15.457, $p < 0.001$), 9.45 (95% Cl, 8.906 to 10.035, $p < 0.001$), 5.959 (95% Cl, 5.605 to 6.335, $p < 0.001$), 3.493 (95% Cl, 3.277 to 3.722, $p < 0.001$) times more likely to influence the above TB incident cases in New York- Newark-Jersey City during this period above. Additionally, this analysis revealed that the persons, aged between 5 and 14 years old were approximately 0.86 (95% Cl, 0.787 to 0.931, $p < 0.001$) times as likely to be contributed to the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017.

Based on the statistically significant $p < 0.001$ of each predicting variable in research question one, it was likely to say that the individuals' race/ethnicity, age, and sex were strong predictors of the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017. Using the above statistical results, the null hypothesis of research question one was rejected in favor of the alternative hypothesis indicating that there was a relationship between the individuals' race/ethnicity, age, sex, and the incident cases of TB during 1993-2017 in New York-Newark-Jersey City.

The Poisson regression test also involved the analysis of the COT in relation to the reported tuberculosis cases, which is the dependent variable of this study.

Consequently, the results of this analysis were used for deciding about the hypotheses in research question two.

Table 8: The descriptive statistics showing the gender disparity in attributing to the tb incident cases.

			N	Percent
Factor	Reported Sex	Male	188	49.5%
		Female	192	50.5%
		Total	380	100.0%

Table 9: Parameter estimates showing the effect of age on the reported tuberculosis cases usin the poisson regression model.

							Exp (B)		95% Wald Confidence Interval for Exp(B)	
Parameter	**B**					**Sig.**			**Lower**	**Upper**
(Intercept)	2.706					.000	14.975		14.145	15.853
65 years of age and older	1.785					.000		5.959	5.605	6.335
45-64 years of age	2.246					.000		9.454	8.906	10.035
25-44 years of age	2.679					.000	14.576		13.746	15.457
15-24 years of age	1.251					.000		3.493	3.277	3.722
5-14 years of age	-.155					.000		.856	.787	.931
0-4 years of age	0b	.	.	.	.	.	.	1	.	.
(Scale)	1c									

Table 10: Descriptive statistics showing the estimated numbers of cases that completed therapy Within one year.

			N	Percent
Factor	Completion of Therapy within One Year	Not Completed Therapy within One Year	149	48.9%
		Yes, Completed Therapy Within One Year	156	51.1%
		Total	305	100.0%

Research question 2 and hypotheses

The second research question was formulated about whether the COT was related to the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. Such a variable was used for measuring the percentage of patients that completed their TB therapy within one year or less during this period in New York-Newark-Jersey City (CDC, 2018) [43]. As a reminder, the COT variable was coded as 2 for no, 1 for yes, 99 for not reported, and 999 for not applicable within the created SPSS data set. However, using the Poisson regression model, the 99 and 999 were excluded and treated as missing values in this analysis.

Evaluating the effect of COT on the reported TB cases was done through the parameter estimates of the Poisson regression model. However, other analyses, such as the case processing information, distribution of both the categorical and continuous variables, Omnibus test, and model effect tests were also useful in understanding the significance of COT in impacting the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017.

Looking at table 10, the Poisson regression model showed the numbers and percentages of cases that completed therapy within one year or less (COT). In this analysis, the COT was also considered as a categorical variable. In Table 10, there was an estimated sample of 305 TB patients, 149 (48.9%) did not complete therapy within one year or less. Conversely, 156 (51.5%) participants of the above sample completed their therapy within one year or less in New York-Newark-Jersey City from 1993 to 2017.

From table 11, the Poisson regression model exhibited the numbers of included and excluded cases of TB in this analysis. Of 672 TB incident cases, 305 (45.4%) cases included in therapy completion and 367 (54.6%) cases excluded therapy completion via the Poisson regression analysis.

From table 12, the Poisson regression model showed the reported tuberculosis cases were the dependent variable of this study. Additionally, it had shown the information on data that were over dispersed from analyzing the dependent variable of this study. More importantly, this table had shown a mean of 108.1311, with a standard deviation of 317.88461 of the distribution of data from the dependent variable of this study.

Of this analysis, the Omnibus test had demonstrated the likelihood ration of the COT to improve the Poisson regression model, excluding the dependent variable. Testing for its effect on this model, the COT was statistically significant, with $p < 0.001$. This indicated an overall significant model.

In table 13, the Poisson regression analysis showed the overall effect of COT via the tests of model effects.

Table 11: Descriptive statistics showing the included and excluded cases of therapy completion within one year.

	N	Percent
Included	305	45.4%
Excluded	367	54.6%
Total	672	100.0%

Table 12: The descriptive statistics of the reported tuberculosis cases, the dependent variable of this study.

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	Reported Tuberculosis Cases	305	.00	2417.00	108.1377	317.88461

Table 13: The tests of model effects showing the effect of completion of therapy within one year on the reported tuberculosis cases via poisson regression model.

	Type III		
Source	**Wald Chi-Square**	**Df**	**Sig.**
(Intercept)	303039.976	1	.000
Completion of Therapy within One Year	12297.436	1	.000

Table 14: Parameter estimates showing the effects of the completion of therapy within one year using poisson regression model.

				95% Wald Confidence Interval for Exp(B)	
Parameter	**B**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
(Intercept)	**5.199**	**.000**	**181.160**	**179.060**	**183.285**
No Completion of Therapy within One Year	**1.744**	**.000**	**.175**	**.170**	**.180**
Completion of Therapy within One Year	**0[a]**		**1**		
Scale	**1[b]**				

From this analysis, the COT was found to be statistically significant, with a p < 0.001 indicating that it was a predictor of the reported TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

In table 14, the Poisson regression model displayed the exponentiated coefficients and p-values showing a positive relationship between the COT and reported TB incident cases in New York-Newark-Jersey City from 1993 to 2017.

A Poisson regression analysis was conducted for predicting whether the completion of therapy within one year was a predictor of the TB incident cases from 1993 to 2017 in New York-Newark-Jersey City. In this analysis, the TB incident cases, without therapy completion were 0.175 (95% Cl, 0.170 to 0.180, $p < 0.001$) times more likely to be contributed to the reoccurring TB incident cases between 1993 and 2017 from this region of New York City. A p - value of less than 0.05, with an adjusted odds ration of 1.0 or greater indicates an increased risk of a predicting variable to influence an outcome [154]. Although it was statistically significant, with a $p < 0.05$, the Poisson regression analysis exhibited the effect size of COT was only estimated to 0.175 times of likelihood to influence the incident cases of TB in New York- Newark-Jersey City during 1993-2017. With an odds ratio of 0.175, the COT variable was less likely to influence these incident cases of TB from this area in New York City.

Since the COT variable was statistically significant, with a $p < 0.001$, the null hypothesis of research question two was rejected. In contrast, the alternative hypothesis from this question was accepted for predicting a positive relationship between the COT and the incident cases of TB in New York-Newark-Jersey City during 1993 and 2017. However, the likelihood of COT to influence these incident cases of TB in New York- Newark-Jersey City was minimal.

Research question 3 and hypotheses

The last research question addressed the issue from testing for the isoniazid and rifampin susceptibility (TIRS) as a predictor of the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. From this question, the independent variable, tested for isoniazid and rifampin susceptibility was hypothesized against the dependent variable, reported tuberculosis cases. As previously indicated, the Poisson regression model was used to predict the relationship between the independent and dependent variables of this study.

As previously described, the Poisson regression model is often used for testing the likelihood of a predicting variable in relation to a response variable. However, such a model can exhibit several different statistical tests, with different statistical purposes in showing such a likelihood of a predicting variable to affect an outcome of interest. As such, in this analysis, the Poisson regression model had yielded the case processing summary, statistics involved the categorical and continuous variables of this study, Omnibus test, tests of a model of effects, and the parameter estimates showing the relationship between TIRS and reported tuberculosis cases in Table 15, Table 16, Table 17, Table 18, Table 19.

From table 15, the Poisson regression analysis displayed the case processing summary, which showed the numbers and percentages of included and excluded

Table 15: Descriptive statistics showing the included and excluded cases of isoniazid and rifampin susceptibility.

	N	Percent
Included	308	45.8%
Excluded	364	54.2%
Total	672	100.0%

Table 16: Descriptive statistics showing the reported cases of isoniazid and rifampin susceptibility.

			N	Percent
Factor	Tested for Isoniazid and Rifampin Susceptibility	Yes	151	49.0%
		No	157	51.0%
		Total	308	100.0%

Table 17: Descriptive statistics of the reported tuberculosis cases, the dependent variable of this study.

N		Minimum		Maximum	Mean	Std. Deviation
Dependent Variable	Reported Tuberculosis Cases	308	.00	1576.00	80.8571	217.74781

Table 18: The tests of model effects showing the relationship between the tirs and reported tuberculosis cases via the poisson regression model.

	Type III		
Source	**Wald Chi-Square**	**df**	**Sig.**
(Intercept)	349850.098	1	.000
Tested for Isoniazid and Rifampin Susceptibility	5575.982	1	.000

Table 19: The parameter estimates showing the effect of tirs on the reported tuberculosis cases through the poisson regression model.

								95% Wald Confidence Interval for Exp(B)	
Parameter	**B**					**Sig.**	**Exp(B)**	**Lower**	**Upper**
(Intercept)	3.726					.000	41.497	40.501	42.517
Tested for Isoniazid and Rifampin Susceptibility	1.077					.000	2.935	2.853	3.019
Not Tested for Isoniazid and Rifampin Susceptibility	0a	.	.	.	.	.	. 1	.	.
Scale	1b								

TIRS cases of this study. Of 672 incident cases of TB, there were 308 (45.8%) cases of TIRS and an estimated 364 incident cases of TB were linked to the missing data of this analysis. Notably, these 364 cases were excluded due to missing values of the TB data set reported for New York-Newark-Jersey City from 1993 to 2017. Besides processing the TIRS cases, the Poisson regression analysis treated it as a categorical variable.

As previously indicated, the Poisson regression model had treated the TIRS as the categorical variable. Looking at Table 16, this analysis had revealed a total of 308 TB incident cases of which 157 (51.0 %) of them were not associated with isoniazid and rifampin susceptibility. Conversely, 151 (49.0%) of these cases were linked to isoniazid and rifampin susceptibility between 1993 and 2017 in New York-Newark-Jersey City.

In table 17, the Poisson regression analysis showed the dependent variable, reported tuberculosis cases of this study, was a continuous variable. This statistic test also displayed an estimated mean of 80.8571, with a standard deviation of 217.74781 distributing the data from the response variable in table 17.

Like in previous sections of this analysis, the Poisson regression model had exhibited in table 18, the Omnibus test. This statistical feature of the above statistic test had shown the likelihood of the independent variable (TIRS) to enhance the model over the intercept model. Specifically, when adding the TIRS variable, this model had exhibited a significant $p < 0.001$ signifying a statistically significant overall model. A resulting $p < 0.001$ from this statistic test indicating that the TIRS was a predictor of the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

From table 18, the Poisson regression model had revealed the likelihood of the TIRS to affect the incident cases of TB between 1993 and 2017 in New York-Newark- Jersey City. Specifically, this statistic test had demonstrated that the TIRS was statistically significant, with a $p < 0.001$ showing the overall effect of this predicting variable on the dependent variable, reported tuberculosis cases from this area in New York City.

Unlike the tests of model effects, the parameter estimates showed the effect sizes and significant p - values between the predicting variable, TIRS and the TB incident cases in New York-Newark-Jersey City during 1993-2017. From Table 19, the Poisson regression analysis showed the incident cases of TB that tested for isoniazid and rifampin susceptibility were 2.94 (95% Cl, 2.853 to 3.019) times more likely to be associated with the TB incident cases from this area in New York City during this period. The effect size of TIRS was supported by a statistically significant $p < 0.001$ indicating that this variable was a strong predictor of the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017.

Based on the resulted coefficient and p-values of this analysis, the null hypothesis in research question three was rejected. Conversely, the alternative hypothesis was accepted for indicating that there was a relationship between TIRS and the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017.

Summary

In this quantitative analysis study, the relationship between the individuals' race/ethnicity, age, sex (gender), and issues of completion of TB therapy within one year and isoniazid and rifampin susceptibility, and the incident cases of TB during 1993-2017 in New York-Newark-Jersey City were investigated. As a statistical method, the Poisson regression model was used to reveal the findings in the predictive relationship between the independent and dependent variables of this study.

In research question number one, the hypotheses were constructed by questioning whether the individuals' race/ethnicity, age, and sex (gender) were related to the incident cases of TB in New York-Newark-Jersey City. From this question, the Poisson regression analysis showed that that race/ethnicity and covariates, age and sex were statistically significant, with a common $p < 0.001$ as predictors of the incident cases of TB during 1993-2017 in New York-Newark-Jersey City. Therefore, the null hypothesis from this question was rejected in favor of the alternative hypothesis for indicating that

race/ethnicity, age, and sex (gender) were related to these incident cases of TB from this area in New York City.

Chapter 4 included the analysis of the COT variable against the reported tuberculosis cases, which was the dependent variable of this study. Using the Poisson regression test, this analysis showed that the COT was statistically significant, with a $p < 0.001$ indicating a positive relationship between the COT predictor and the reported TB incident cases in New York-Newark-Jersey City during 1993-2017. Therefore, the null hypothesis of research question two was rejected in favor of the alternative hypothesis for stating that there was a relationship between the COT and incident cases of TB in New York-Newark-Jersey City from 1993 to 2017.

The last section of this analysis involved the third research question interrogating whether the TIRS was related to the incident cases of TB in New York-Newark-Jersey City during 1993-2017. From this question, the null hypothesis assumed that there was no relationship between the TIRS and these incident cases of TB in New York-Newark- Jersey. Conversely, the alternative hypothesis indicated that there was a relationship between the TIRS and these incident cases of TB in New York-Newark-Jersey City during 1993-2017.

From the Poisson regression analysis, the TIRS was found to be 2.94 (95% Cl, 2.853 to 3.019) times as likely to influence the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017. This statistic result indicated that the issue of isoniazid and rifampin susceptibility was a strong predictor of these incident cases of TB from this area in New York City. Thus, the null hypothesis from research question three was rejected in favor of the alternative hypothesis for indicating that there was a relationship between the TIRS and the incident cases of TB in New York-Newark-Jersey City during 1993-2017. After analyzing data in chapter 4, interpretations of the data are given in chapter 5.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to investigate the relationship between the individuals' demographic characteristics, issues of therapy and drug susceptibility, and the incident cases of TB in New York-Newark-Jersey City during 1993-2017. Using a quantitative retrospective cohort design, I explored the relationship between race/ethnicity, age, and sex (gender), issues of completion of therapy within one year, isoniazid and rifampin susceptibility, and the TB incident cases in New York-Newark- Jersey City from 1993 to 2017. The retrospective cohort design was appropriate in conducting this study because the design is often feasible in studies involving the investigation of several risk exposures for an outcome of interest in a large population for a long period of time (see Setia, 2016) [142]. Likewise, this study design was the best method for investigating the relationship between the individuals' race/ethnicity, age, sex (gender), issues of therapy and drug susceptibility, and TB incident cases for over 25 years in New York-Newark-Jersey City.

Using the appropriate statistical method is critical for a succinct research study. In this quantitative analysis study, the Poisson regression model was used to analyze the relationship between the independent and dependent variables. The UCLA, Institute for Digital Research & Education (n.d.) [146] noted that such a statistical method is commonly used for predicting the relationship between various risk factors for an outcome in a given population. The statistical model was useful for analyzing whether race/ethnicity, age, sex (gender), and the issues of therapy completion and isoniazid and rifampin susceptibility were predictors of the TB incident cases from New York-Newark-Jersey City. Using these variables, the following research questions were created by hypothesizing whether the independent variables were related to the reported TB cases outcome in New York-Newark-Jersey City from 1993-2017.

*RQ*1. Is there a relationship between race/ethnicity and covariates (age and sex), and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City?

H0 1. There is no relationship between race/ethnicity and covariates (age and sex), and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

H1 1. There is a relationship between race/ethnicity and covariates (age and sex), and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

*RQ*2. Is there a predictive relationship between the completion of therapy within one year and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City?

H0 2. There is no predictive relationship between the completion of therapy within one year and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

H1 2. There is a predictive between completion of therapy within one year and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

*RQ*3. Is there a predictive relationship between the cases that tested for isoniazid and rifampin susceptibility to the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City?

H0 3. There is no predictive relationship between the cases that tested for isoniazid and rifampin susceptibility

to the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

H1 3. There is a predictive relationship between the cases that tested for isoniazid & rifampin susceptibility and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City**.**

The Poisson regression is the best model for predicting several risk factors of an issue. For this study, this statistical model was crucial in analyzing and responding to the hypotheses. The Poisson regression model was useful in analyzing whether the predictors of each research question were related to the response variable, reported TB cases.

Consequently, this statistical test yielded the results for the research questions and hypotheses.

Summary of key findings

Research question one hypothesized whether race/ethnicity and covariates, age and sex (gender) related to the TB incident cases between 1993 and 2017 in New York- Newark-Jersey City. Using the Poisson regression model, the race/ethnicity variable was used as the primary risk factor, and the age and sex (gender) demographics were considered as the covariates in this part of the analysis. For research question one, the Poisson regression analysis revealed that Blacks, Hispanics, and Asians were correspondingly 2.4 (95% Cl, 2.364 to 2.512; $p < 0.001$), 2.1 (95% Cl, 2.031 to 2.161; $p < 0.001$), 1.8 (95% Cl, 1.782 to 1.899; $p < 0.001$) times as likely to be affected by TB between 1993 and 2017 in New York-Newark-Jersey City.

Conversely, the Poisson regression model revealed that the Multi-racial and Native Hawaiians were only 0.025 (95% Cl, 0.021 to 0.031; $p < 0.001$) and 0.001 (95% Cl, 0.001 to 0.003; $p < 0.001$) times as likely to contribute to these incident cases of TB between 1993 and 2017 in New York-Newark-Jersey City. Additionally, the Poisson regression model displayed the statistics showing the relationship between the individuals' age, sex (gender), and incident cases of TB between 1993 and 2017 from this area in New York City.

From this analysis, the age variable was 1.32 (95% Cl, 1.311 to 1.327, $p < 0.001$) times more likely to influence their exposure to TB during this period in New York- Newark-Jersey City. Conversely, the sex or gender variable was 1.56 (95% Cl, 1.526 to 1.584, $p < 0.001$) times more likely for TB to affect males than females in New York- Newark-Jersey City. However, the coefficients and *p*-values were inconclusive as to which sex (gender) or age group was more likely to influence the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017. Consequently, both age and sex (gender) were analyzed against the incident cases of TB during this period from this area in New York City.

Testing for sex (gender) distribution, the Poisson regression model showed a disadvantage for males in contributing to the TB incident cases in New York-Newark- Jersey City from 1993 to 2017. Specifically, this analysis revealed that males were 1.58 (95% Cl, 1.554 to 1.613, $p < 0.000$) times more likely than females to have the disease during 1993-2017 in New York-Newark-Jersey City. In addition to analyzing which sex group was at higher risk of contributing to TB, the Poisson regression also analyzed the individuals' age group against the reported TB cases in New York-Newark-Jersey City.

As displayed in Table 11, the Poisson regression model revealed that the persons whose ages were between 24-44 years, 45 - 64 years, 65 + years, and 15-24 years were correspondingly 14.56 (95% Cl, 13.746 to 15. 457, $p < 0.001$), 9.45 (95% Cl, 8.906 to 10.035, $p < 0.001$), 5.96 (95% Cl, 5.605 to 6. 335, $p < 0.001$), 3.49 (95% Cl, 3.277 to 3.722, $p < 0.001$) times more likely to influence the TB incident cases in New York- Newark-Jersey during 1993-2017. Conversely, the likelihood of the age group 2 (i.e., 5- 14 years) to influence the incident cases of TB was estimated to only 0.86 (95%Cl, 0.787 to 0.931, $p < 0.001$) times as likely to impact these phenomena of TB from 1993-2017 in New York-Newark-Jersey City.

The coefficients were partially associated with responding to the hypotheses of research question one. These statistical values were also statistically significant, with a common $p < 0.001$, indicating a positive relationship between the individuals' race/ethnicity, age, sex (gender), and the TB incident cases in New York-Newark-Jersey City during 1993-2017. Consequently, the null hypothesis of research question one was rejected. In contrast, the alternative hypothesis was accepted because there was a relationship between the race/ethnicity, age, and sex (gender) demographics and the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

In the second research question, the COT was hypothesized as the predictor of the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. Using the Poisson regression model, the COT was treated as the risk factor to be analyzed against the response variable, reported TB cases of this study. From this analysis, the Poisson regression showed that the cases without COT were only 0.175 (95% Cl, 0.170 to 0.180, $p < 0.001$) times as likely to influence the incident cases of TB during 1993-2017 in New York-Newark-Jersey City. As previously indicated, such a coefficient value was small and suggested that the COT was less likely to influence these incident cases of TB during this period in New York-Newark-Jersey City.

Despite being small, the coefficient value of the COT variable was statistically significant, with a $p < 0.001$. Therefore, the null hypothesis in research question two was rejected. Conversely, the alternative hypothesis of

this question was accepted for indicating that there was a relationship between the COT and TB incident cases between 1993 and 2017 in New York-Newark-Jersey City.

The last research question of this study was based on the hypothesis of whether testing for isoniazid and rifampin susceptibility (TIRS) was related to the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017. Consequently, the Poisson regression model was used to analyze the TIRS variable against the reported TB cases, which was the dependent variable of this research. From this analysis, the TIRS variable was found to be 2.935 (95% Cl, 2.853 to 3.019; $p < 0.001$) times as likely to influence the phenomena of TB incidence in New York-Newark-Jersey City during 1993-2017. Thus, it was likely to say that the TIRS was a strong predictor of the incident cases of TB from this area in New York City. Often, the findings of a research study are crucial in conforming or disconfirming previous outcomes and theory related to such a study.

Interpretation of the findings

As a reminder, this study was guided by the epidemiological triad theory. Such a philosophical perspective assumes that the age, sex (gender), and environmental risk factors (e.g., geology, climate, biological, and socioeconomic status) can influence the occurring incidence of an infectious disease a given population [28]. The socioeconomic status may be defined as the issues in crowding, sanitation, and availability of health services in such a population [28]. Speaking of theory, Trafimow (2013) indicated that the assumptions of a theory often allow researchers to predict the cause and effect of an outcome in an environment. Similarly, the assumptions of the epidemiological triad theory were adopted in investigating the relationship between the individuals' race/ethnicity, age, sex (gender), COT, TIRS, and the reported TB incident cases in New York-Newark-Jersey City.

The epidemiological triad theory assumes the individuals' age and sex are intrinsic risk factors for exposing them to an infectious disease. Likewise, in this study, the race/ethnicity, age, and sex (gender) demographics were found to be strong predictors of the TB incident cases in New York-Newark-Jersey City from 1993 to 2017.

The assumptions of a theory must be interrelated with the findings of a research study. Trafimow (2013) indicated that the findings of a research study can be used to confirm or disconfirm both the theoretical perspectives and previous findings related to the subject under the investigation. As such, the data analysis of this study revealed that the individuals' age and sex were statistically significant, with a p - value $p < 0.001$ indicating that the above variables were strong predictors of the TB incident cases in New York-Newark-Jersey City during this period above.

The above statistical results were useful in confirming that both age and sex demographics were related to the incident cases of TB between 1993 and 2017 from New York-Newark-Jersey City. Most often, researchers investigated other risk factors that were not suggested by the theories of their studies (Trafimow, 2013). Likewise, this study investigated other risk factors, such as race/ethnicity and issues of therapy completion and isoniazid and rifampin susceptibility.

The race/ethnicity demographic is currently an influential risk factor for TB, globally. Noppert, et al. (2017) [10] and Wilson, et al. [134] indicated that the race/ethnicity risk factor is commonly associated with the incidence of TB in the United States.

Likewise, the findings of this study showed that race/ethnicity was statistically significant, with a $p < 0.001$ indicating that race/ethnicity was a predictor of the TB incident cases for the past 25 years in New York-Newark-Jersey City. Therefore, the inclusion of race/ethnicity as a risk factor for an infectious disease is strongly suggested for improving the epidemiological triad theory. Also, the issues of therapy and drug susceptibility impacted the incidence of TB worldwide.

As such, the COT and TIRS were directly related to the incident cases of TB in New York-Newark-Jersey City during 1993-2017. Bhavnani, et al. [27] argued about this issue by indicating that the lack of therapy completion has an influence on the incident cases of TB in New York City. Likewise, the WHO (2018) [45] reported that both therapy and drug susceptibility issues have recently prevented the efforts of health care providers and public health professionals from eradicating TB in the world.

Consequently, in this study, I investigated the relationship between COT, TIRS, and incident cases of TB from 1993 to 2017 in New York-Newark-Jersey City.

Both the COT and TIRS were found to be statistically significant, with a $p < 0.001$ as one of the predictors of the incident cases of TB between 1993 and 2017 in New York-Newark-Jersey City. However, there was a major gap in the literature of TB, whereby previous studies had not thoroughly investigated the relationship between the COT, TIRS, and these incident cases of TB in New York-Newark-Jersey City and the United States. Therefore, the findings of this research were of great public health significance by filling this gap in the literature of TB research in New York-Newark- Jersey City and the United States. Additionally, the findings of this study were critically important for advancing knowledge in the TB research discipline.

Limitations of the study

Using the 1993-2017 TB data set of the CDC wonder's website was a limitation to this study. The CDC agency organized this data set into the group level, which made the findings of this study susceptible to ecologic bias.

Such a type of bias has often arisen from the loss of data or information of a grouped data set [155,156,157]. Using an aggregate or grouped data set often prevented researchers from interpreting the findings of their studies at individual levels [155,156,157]. Likewise, the 1993-2017 TB data set contained some missing data and cases, with zero values for a unique ethnic group (CDC, 2018) [43].

This partially represented an ecologic bias of this study.

Ecologic bias can be observed in individual-based research. Webster (2002) [157] indicated that it is possible to have a partial ecologic bias in the findings of the individual-based public health research studies. Often, such an issue was based on the measurement errors of the risk exposures from an aggerate data set [157]. To avoid the ecologic bias in interpreting the findings of an individual-based research study, researchers must interpret these findings by group level (Krause, 2017). Such a suggestion was used to interpret the issue of missing data cases, with zero values of an ethnic group of TB patients in New York-Newark-Jersey City during 1993-2017.

As previously indicated, this study was conducted using the 1993-2017 TB data set from the CDC's website. This data set included cases, with zero values from a certain ethnic group of TB patients in New York-Newark-Jersey City (CDC, 2018) [43]. However, the incident cases, with zero values were not indicative of whether this ethnic group was not affected by the TB incident cases from this area in New York City during 1993-2017 [43]. In research, such an issue is problematic and often called zero-inflated or excess of zero counts of a data set [146]. Not all statistical models can be used for analyzing counted data, with excess zero values.

Often, the zero-inflated issue has limited certain studies to using fewer statistical methods. Likewise, the excess zero values limited the data analysis of this study to either use the Poisson regression or negative binomial models. As previously indicated in the methodology section, the Poisson regression model was appropriate for analyzing the data of this study. Because of the excess zero values, the Poisson regression model failed to exhibit a mean value that was equal to the variance in the descriptive statistics displayed in Table 1. So, the reported tuberculosis cases (e.g., dependent variable) violated the assumption of probability distribution because of the over dispersed data from the 1993-2017 TB data set.

The over dispersed data issue was previously seen in studies of counted data using the Poisson regression test. Therefore, such an issue could not prevent the analysis of data from this study using the Poisson regression model. Instead, the Omnibus test was statistically significant, with a $p < 0.001$ indicating the likelihood of all predicting variables of this study to improve the Poisson regression model. Therefore, the interpretation of results from this analysis proceeded.

The uncertainty about the attribution of one ethnic group could not affect the generalizability of the findings of this study in New York-Newark-Jersey City.

Contrarily, this study involved the investigation of 672 incident cases of TB from six major ethnic groups from this area in New York City. This research also included the TB patients of both gender groups (e.g., males & females) from all age groups (e.g., 0 - 65 and older) in New York-Newark-Jersey City. Therefore, the limitation of this study was minimal and couldn't affect the generalizability of its findings to represent the population of the TB disease from this region in New York. After evaluating the limitation of this research, the following recommendations were provided for future TB researches in New York-Newark-Jersey City.

Recommendations for future studies

The New York-Newark-Jersey City is among the most vulnerable regions for the reoccurrence of TB incidence in the United States. In 2018, the incidence rate of TB has been slowly declined from 7.5 in 2017 to 6.8 in New York City [158]. Despite declining, this infectious disease has remained to be dangerous among the inhabitants in New York-Newark-Jersey City. As previously indicated, the data of TB patients among some ethnic groups were unavailable in the 1993-2017 TB dataset. Therefore, the unavailability of data from these patients represented a limitation to this study. However, such a limitation was minimal and couldn't prevent the generalizability of the findings of this TB research in New York- Newark-Jersey City.

It is doubtful in accepting that the TB incidence rate is currently declining in New York-Newark-Jersey City. Recently, the New York City Department of Health has reported that the TB incidence rate of TB is estimated at 6.8 per 100,000 persons. However, there is still uncertainty as to whether this report is accurate. Such a statement is relevant because of the missing data and cases, with the excess zero values that were reported for some TB patients in the OTIS database. Based on this issue, it is strongly recommended that further TB researches be conducted on the reasons why the attribution of a certain ethnic group of TB patients was not reported in the OTIS database between 1993 and 2017 in New York-Newark-Jersey City.

The strength of this research was greater than its limitation. As a reminder, this study suggested the justification in the issues of TB therapy completion and drug susceptibility as predictors of the TB incidence in New York-Newark-Jersey City. Such a suggestion has been confirmed by the statistically significant, with a $p < 0.001$ indicating a positive relationship between the COT, TIRS, and the TB incident cases in New York-

Newark-Jersey City. Currently, little research is done on the above issues in relation to the incident cases of TB in New York-Newark-Jersey City. Consequently, based on the findings of this research, it is strongly recommended that future studies be conducted on the issues connected to therapy completion and isoniazid and rifampin susceptibility as the preventable risk factors for TB in New York-Newark-Jersey City.

Implications of social change

The findings of this study might impact a positive social change among ethnic minorities New York-Newark-Jersey City. Maton [159] indicated that a positive social change may be done by empowering the burdened groups of persons in a given community or society. In New York-Newark-Jersey City, the Asian, Black, and Hispanic ethnic minorities have represented the burdened ethnic groups of persons, with the highest tuberculosis incident cases for the past two decades. For many years, researchers have repeatedly revealed the vulnerability of these ethnic groups in acquiring TB from this area in New York City.

Likewise, in this study, the findings showed that the Asians, Blacks, and Hispanics have been disproportionately affected by the incident cases of TB in New York-Newark-Jersey City from 1993 to 2017. Consequently, the results of this research might create a positive social change by influencing public health professionals in designing an effective TB intervention addressing the individuals' race/ethnicity as a risk factor to reduce the burden of TB from this region in New York City. However, other ethnic groups will be benefited from this initiative in New York- Newark-Jersey City.

It will be important for such TB intervention to be designed in order to prevent TB among persons of other ethnicities in New York-Newark-Jersey City. Maton [159] also indicated that bringing a positive social change into a community must not exclude certain ethnic groups of this environment. From this study, the Multi-racial and Native Hawaiians have been correspondingly categorized as fourth and fifth ethnic groups that were affected by the incident cases of TB between 1993 and 2017 from the above area in New York City. Therefore, the findings of this study also suggested the design of such a TB intervention about reducing TB among these ethnic groups above in New York- Newark-Jersey City.

An effective TB intervention must be initiated for empowering both the ethnic minorities and persons of other ethnicities in New York-Newark-Jersey City. However, fulfilling such a task may require public health professionals to be aware of the circumstances or conditions that might expose the residents of a community to an infectious disease [28]. Thus, it is strongly suggested that these public health servants investigate the environmental risk factors that might influence the exposure of the inhabitants of New York-Newark-Jersey City to TB.

Environmental risk factors may have different definitions. According to the CDC (2012) [28], they are the individuals' socio-economic status, lack of health care, social conditions, and behavioral issues that have often evoked the incidence of an infectious disease in a given population. As such, the behavioral issues, such as misconception about TB prevention and care, substance, and alcohol use, and refusal of HIV testing had impacted the TB incident cases in New York-Newark-Jersey City Dawson, et al. 2016, [137,26,1,138,9,5]. Other issues were found to be associated with the above incident cases of TB from this area in New York City.

Both therapy and lack of access to TB care impacted these incident cases of TB in New York-Newark-Jersey City. For instance, the issues of therapy incompletion and lack of health insurance have been associated risk factors for TB among patients of diverse ethnic groups in New York-Newark-Jersey City [27,138,1,2,9,5]. Likewise, the findings of this study showed that the issues of therapy incompletion and isoniazid and rifampin susceptibility were associated with the incident cases of TB between 1993 and 2017 in New York-Newark-Jersey City.

Using the above statistical findings from this research, public health professionals will be better equipped for designing an effective TB intervention for New York-Newark- Jersey City. With the help of this study, such inspiring TB intervention will be brought a positive social change by empowering the residents, regardless of their race/ethnicity, age, or sex orientations to change their behaviors towards TB prevention and care from this region in New York City.

The findings of this study will provoke the public health servants to investigate how patients of certain ethnic groups have been disproportionately affected by the escalation of TB in New York-Newark-Jersey City. Therefore, knowing about the reasons for such a high burden of TB incidence among the Asian, Black, and Hispanic is imperative for designing a new TB intervention from the above area in New York City.

This research will be informative to both public health professionals and health care providers in New York-Newark-Jersey City. As such, its findings will help in improving their knowledge in tuberculosis practice by providing the quality of care they have desired to deliver to their TB patients in New York-Newark-Jersey City.

The positive social change of a situation often accompanies a change of policy concerning that issue in an environment. Likewise, the findings of this research are subjected to influence the public health professionals to oversee the policy regarding healthcare for TB patients, regardless of their immigration status in New York-Newark - Jersey City. In cases of a change or modification of the law that governs the health care for TB patients, it will be likely that the lack of access

to TB care issues will be eliminated by allowing access for TB care among all TB patients across this region in New York City. Based on these preventive measures, the incidence of TB will be prevented or reduced in New York-Newark-Jersey City.

Conclusion

The findings of this research were of great public health significance by showing the individuals' race/ethnicity was the primary predictor of the TB incident cases between 1993 and 2017 in New York-Newark-Jersey City. As such, the results of this research demonstrated that the age and sex (gender) covariates have been influential risk factors in these incident cases of TB from this area in New York City. More importantly, the findings of this research had justified that both inadequate therapy completion and isoniazid and rifampin susceptibility were associated with these incident cases of TB between during the period in New York-Newark-Jersey City. As previously indicated, both COT and TIRS were statistically significant, with a $p < 0.001$ indicating that they were two of the predictors of the TB incident cases between 1993 and 2017 in New York- Newark-Jersey City.

Dedication

First, I dedicate my research study to God, who has provided me with the strength and wisdom to complete this project. Second, I offer this scientific work to my parents, Mrs. Sifiance Garcon and late father, Iliera Garcon, from whom I inherited resilience and perseverance going through the challenges in this life. Third, I dedicate this research to my beloved children, Irlandjie Sheska Garcon and Ishan Ian Garcon, who have inspired me daily to earn my doctorate degree. Additionally, I dedicate this research to my siblings Amalia Erne, Iltane Blaise, Olonne Delice, Ghislaine Augustin, Iltive Garcon, and Dr. Michelet Garcon, who confided in my ability to succeed not only in this project but also in the tasks that seemed to be impossible for others to achieve. Finally, I offer this research to those infected with tuberculosis, hoping they will get well soon.

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