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Patient Characteristics and Treatment Outcomes Among Tuberculosis Patients in Sierra Leone

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Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Despite decades of the implementation of the directly observed therapy short-course (DOTS), Sierra Leone is ranked among the 30 highest TB-burdened countries. Several factors account for unfavorable treatment outcomes, among which are patient characteristics. Previous studies have only focused on treatment compliance without any consideration for the factors that lead to noncompliance to treatment. The purpose of this study was to investigate patient characteristics that are associated with treatment noncompliance (treatment not completed) among TB patients undergoing the DOTS program in Sierra Leone. A retrospective longitudinal quantitative design was used to analyze secondary data from the completed records of 1,633 TB patients, using the Andersen's behavioral model of health services utilization as a theoretical framework work. Descriptive statistics and bivariate and multivariate logistic regressions were used to analyze the data. The results show that there was no significant association between treatment completion and age, gender, and TB-case category. On the other hand, being HIV-positive decreases the odds of treatment completion. Also, the educational level, geographic location, and year of treatment were significantly associated with treatment completion. Overall, program performance improved as the number of dropouts decreased significantly between 2013 and 2015. The social change implication of this study was that it identified HIV-positive patients and rural communities as areas needing specific attention such as the assignment of case managers to ensure compliance thereby improve DOTS program performance, thereby reducing the incidence and transmission of TB.

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Dedication

This work is dedicated to the most important people in my life: my dad, Alhaji Barba Karim Sesay; my late mom, N'na Kadiatu Sundukun Sesay; my late aunt, N'thenen Fatmata Sesay; my late uncle, Alhaji Hassan Koroma (may their souls rest in eternal peace); my loving wife, Rugie; and my wonderful daughters, Kadie, Iye, N'na Fatu, and N'boh-Fanta.

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Chapter 1: Introduction to the Study

Introduction

Tuberculosis is a major global public health threat despite tremendous efforts to treat and control the disease using affordable drugs (Anuwatnonthakate et al., 2008). In 2014 alone, about 9,600,000 people were said to be infected with TB (World health Organization, [WHO], 2015). It is the second most deadly disease in the world, accounting for 1,500,000 deaths worldwide in 2014 (WHO, 2015). All told, tuberculosis affects about 2 billion people worldwide (Gordin & Masur, 2012; WHO, 2015).

Tuberculosis remains one of the most infectious and deadly diseases in Sierra Leone. The number of reported tuberculosis cases had almost doubled since the declaration of a millennium development goal in the year 2000 from 6,737 in 2005 to 12,477 in 2014 (WHO, 2015). Sierra Leone is among the 30 countries with the highest burden of TB with at least 10,000 cases per year (WHO, 2015). According to WHO (2016), the total number of deaths from tuberculosis in Sierra Leone reached a high of 8,131 in 2014, accounting for 8.6% of the number of total deaths in the country. The age-adjusted death rate from tuberculosis is 230.17 per 100,000 people, which places Sierra Leone in the unenviable position of ranking number one in the world (WHO, 2016).

It has been reported that the continued rise in the incidence of TB can be attributed to a number of factors such as poverty, overcrowding, unavailability of drugs, drug resistance, and poor compliance (Ministry of Health and Sanitation [MOHS], 2010). There is increased concern that TB/HIV comorbidity and the emergence of multidrug resistant TB will exacerbate an already high TB mortality rate in the country (MOHS,

2010). The continued upward trajectory of TB rates makes it urgent to mount sustained efforts to continue the fight against the disease. The interplay of several risk factors both structural, such as type of housing, overcrowding, and homelessness (Garfein et al., 2010), and individual risk factors such as smoking (Horne et al., 2012), age (Syed, 2014), HIV coinfection (Garfein et al., 2010; Kendall, 2012), and multidrug resistance (Kendall, 2012) has influenced this trajectory. There is a need for the understanding of these forces by both policy makers and healthcare givers in order to slow down the trajectory. However, to my knowledge no study has been conducted to explain the contribution of patient characteristics that are associated with noncompletion of TB treatment in Sierra Leone. Therefore, the purpose of this research was to investigate the effect of patient characteristics on the completion of TB treatment among patients enrolled in the directly observed therapy short-course (DOTS) program in Sierra Leone. My aim was to find out whether there is a relationship between treatment completion and patient's age, gender, HIV status, and TB category. An understanding of such relationship will help policy makers and healthcare providers develop strategies to target such groups and improve on treatment completion rate.

In this chapter, I will briefly present a background review of the topic, focusing on the gap that exists in the literature. I will then explain the problem statement, the purpose of the study, the research questions, the hypothesis that I proposed, and provide a brief discussion of the theoretical framework which this study was grounded on. I will endeavor to define key terms as they apply to this research and state the limitations and assumptions of the study. In the chapter, I will also describe the scope and the boundaries

of the research. It will conclude with a section on the potential contributions of the study to program implementation and success, applicability to treatment guidance, policy formulation, and its overall potential for creating social change.

Background of the Study

TB is a contagious disease caused by the microorganism *Mycobacteria tuberculosis* (Butler & Carr, 2013; Driver, Matus, Bayuga, Winters, & Munsiff, 2005; Kendall, 2012). It is among the oldest diseases known to affect humans (Driver et al., 2005). TB is a chronic disease that affects the lungs (pulmonary tuberculosis), but can also affect other parts of the body (extrapulmonary TB) such as the brain, kidneys, bones, and spine (Kendall, 2012). The disease is transmitted from one person to another through droplet infections (Kendall, 2012).

The majority of people infected with TB remain largely asymptomatic; they are not infectious and cannot transmit the disease to other people (Center for Disease Control and Prevention [CDC], 2012). The people who carry the infection without manifesting any clinical symptoms have a latent TB infection (LTBI; CDC, 2013). When healthy, they do not transmit the disease to other people in their environment. The infection is kept under control by the body's immune system. However, about 10% of those infected with LTBI may develop the full-blown disease in their lifetime, known as TB disease or active TB (Gordin & Masur, 2012). This is especially common in persons with a weakened immune system such as HIV/AIDS patients (Gordin & Masur, 2012).

TB Disease/Active TB

A congruence of factors both personal and environmental may influence the progression of LTBI to active TB disease. People with LTBI who have come into contact with active TB patients and had been recently infected (within 2 weeks) are most likely to develop active TB (CDC, 2016). Other people develop the disease over a long time after their immune systems have been compromised. It is believed that infection with HIV/AIDS, chronic renal failure, and diabetes accelerates LTBI to active TB disease (CDC, 2016; Gordin & Masur, 2012). Generally, the people with higher risk of developing full-blown TB are immunocompromised patients such as those with HIV, children under 5 years of age, and institutionalized persons such people living in homeless shelters and injection drug users (CDC, 2016). Healthcare workers working with at-risk patients are also at increased risk of contracting the infection, especially in developing countries where attention to infection controls is less rigid (CDC, 2016).

Symptoms

The majority of people with TB infection do not show any signs and symptoms (CDC, 2016). Some of the symptoms of active TB are common to other diseases and may be different depending on the organ that is being affected (CDC, 2016). It is imperative that TB diagnosis is based not just on clinical symptoms but backed by at least one TB test (CDC, 2016). Patients with active pulmonary TB disease experience a prolonged cough lasting more than 2 weeks, chest pain, shortness of breath, and sometimes coughing up blood or phlegm from deep down in the lungs (hemoptysis; CDC, 2016. The

patient may also experience recurrent fever, chills, loss of appetite, weight loss, and night sweats (CDC, 2016).

Diagnosis

The Mantoux tuberculin skin test, or simply TB skin test, and the interferon-gamma release assay (IGRA) blood test, are the two main methods used to screen for TB infection (CDC, 2016). Additional tests such as smear microscopy, chest radiography, lymph node biopsy, and blood fluid examination are performed to confirm the presence of TB disease (CDC, 2016.

The TB skin test contains tuberculin purified protein derivative, which when injected under the skin elicits a delayed immune response in TB infected patients (WHO, 2016). This can be detected by the appearance of a circular swelling around the point of injection, and the result of the test can be interpreted within 48 to 72 hours (CDC, 2016). The size of the swelling determines whether the person is positive or negative. A negative result indicates that the person did not have the bacteria; however, a positive result indicates that the person has been exposed to the bacteria but does not necessarily have active TB disease (CDC, 2016).

The IGRA is a blood test that is also used for diagnosing TB. There are two types of IGRA used: QuantiFERON TB Gold and the T-Spot TB tests (CDC, 2016). The blood test detects cytokines released by a person's immune response in response to the presence of TB bacteria in the blood of the infected (CDC, 2016).

In both cases, the tests do not differentiate between LTBI and active infection. The TB skin test often gives false positive results to those who have been vaccinated with

Bacillus Calmette–Guérin (BCG) vaccine for TB prevention. BCG vaccine is administered in highly endemic countries (CDC, 2016). Further tests are required with support from clinical expressions to confirm active infection.

Sputum smear microscopy. Sputum smear microscopy is the gold standard used for the diagnosis of TB in countries with high rates of TB infection. In 2012, the WHO recommended the collection of two specimens from patients on the same day for sputum smear microscopy (Kirwan, 2012). The Ziehl-Neelsen acid-fast staining technique is used to detect the presence of TB bacteria under a microscope (Gordin & Masur, 2012). The technique is inexpensive, and results can be obtained within hours. The disadvantage of the system is its low sensitivity, with a detection rate of 30% to 60% (Gordin & Masur, 2012). The sputum smear TB test has been augmented by the use of fluorescent microscopy to increase the detection rate (Gordin & Masur, 2012).

Culture and chest x-ray. TB can be diagnosed by the use of X-ray and cultural techniques. Culturing the bacteria in an enrichment broth significantly increases the quantity of the bacteria, making it easier to detect (Gordin & Masur, 2012). Culturing is also used to test for susceptibility of the bacteria to known anti-TB drugs. It can also help to identify whether an individual has naïve mycobacteria or has developed a resistant species causing multidrug resistant (MDR) TB or extensively drug resistant (XDR) TB discussed later in this section. The use of culturing techniques for resource-poor nations such as Sierra Leone is challenging as it requires complex, expensive equipment beyond the reach of those nations. It also takes a longer time to arrive at a conclusive diagnosis.

Extra-pulmonary TB (EPTB) diagnosis. The method of choice for the diagnosis of EPTB disease is the use of histopathology and microscopic staining techniques (Purohit & Mustafa, 2015). In this method, a biopsy of the lymph node or lungs is performed to excise a minute portion of the affected organ, and the pieces are then stained and histologically analyzed (Purohit & Mustafa, 2015). The presence of granulomatous inflammation in the affected area and some Langhan's giant cells are indicative of TB disease (Purohit & Mustafa, 2015). Fine needle aspiration cytology can also be performed to examine body fluids such as cerebrospinal fluids and pleural fluids for EPTB disease (Purohit & Mustafa, 2015).

Treatment

The aim of a TB treatment program is four-fold: cure the patient, prevent relapse, reduce transmission, and prevent the development of drug resistance. The objective of the short course intense drug regimen is to deliver rapid bactericidal activity and provide sterilizing effect and suppression of the development of acquired drug resistance TB (Pasipanodya & Gumbo, 2013). For these reasons, both LTBI and active TB patients should be treated. The use of a combination of multiple antimicrobial TB drugs is more efficient in treating the bacteria than single-dose drugs (Elkomy, Awad, El-Shora, & Elsherbeni, 2013). The commonly used first-line drug of choice for new patients are isoniazid (INH) rifampicin (RMP), pyrazinamide, ethambutol, and sometimes streptomycin (Elkomy, Awad, El-Shora, & Elsherbeni, 2013). The treatment phase is divided into 2 months (56 doses) of high-intensity chemotherapy with INH, RMP, pyrazinamide, and ethambutol (Elkomy, Awad, El-Shora, & Elsherbeni, 2013). The next

phase is the continuation phase which lasts for 4 or 7 months, involves low-intensity treatment with INH and rifampicin RMP, depending on the patient's circumstance (Elkomy et al., 2013). The majority of the patients whose sputum smear converts to negative after intensive treatment continue their treatments for 4 months more (156 doses; (CDC, 2016). While those whose sputum smear remains positive after the intensive phase will continue their treatment for 7 more months (CDC, 2016).

The under-treatment and noncompliance to a TB treatment regimen leads to the development of multidrug-resistant TB (MDR-TB) (Getahun, Ameni, Medhin, & Biadgilign, 2013). MDR-TB can also be acquired by coming into close contact with MDR-TB patients in highly populated areas, such as hospitals, prison facilities, or shelters for the homeless (CDC, 2016). MDR-TB develops when the TB bacteria are resistant to the two common first-line TB drugs: INH and RMP. In cases where the bacteria are resistant to INH and RMP, as well as at least three of the six classes of the second line anti-TB drugs, the situation is described as XDR-TBCDC, 2016). Treatment of patients with MDR-TB and XDR-TB is complex, as the individual does not respond to the most commonly available TB drugs. The emergence of MDR-TB is alarming, and is a major challenge to TB treatment programs around the world. It is estimated that about 480,000 people had MDR-TB and 190,000 MDR-TB deaths were recorded in 2014 worldwide (WHO, 2016).

Directly Observed Therapy Short-Course (DOTS) vs. Self-Administered Therapy

There are two general methods of medication administration to TB patients. Because a course of long-term treatment is required, some patients receive their

medication supplies and self-administer their medications for the duration of the treatment, referred to as self-administration therapy (Anuwatnonthakate et al., 2008). Other patients receive their treatment through the WHO-recommended DOTS program (Anuwatnonthakate et al., 2008).

DOTS is an internationally recognized treatment protocol that is part of the WHO STOP Strategy for the treatment of TB (Elkomy et al., 2013). The success of DOTS in increasing compliance, reducing the number of new cases, and preventing the development of drug-resistant TB has been widely applauded (Elkomy et al., 2013; Obasanjo, Shields, Coggin, Chaisson, & Glass, 2012). The strategy is comprised of five components: political commitment by national governments, improved laboratory facilities with quality sputum-smear microscopy capabilities, regular supply of anti-TB drugs, direct observation by a health care worker of each patient swallowing their medications, and a standardized recording and reporting system for patient and program success (Pasipanodya & Gumbo, 2013). The proportion of patients' loss-to-follow-up (LTFU) was substantially reduced following successful implementation of DOTS (Obasanjo et al., 2012). As a consequence, the treatment resulted in a reduction in the total number of cases after DOTS among patients followed during a study in Baltimore (Obasanjo et al., 2012).

In a similar study conducted in Thailand, Anuwatnonthakate et al. (2008) found that 2 months of intense DOTS was strongly associated with improved TB treatment outcomes. The researchers found that the greatest effect was realized among patients who were monitored by a healthcare worker compared with those who were monitored by

their family members. DOTS had a greater effect on reducing default rate among TB patients in the study as well. These results were consistent with similar findings by Pungrassami et al. (2002), who observed that patients who were monitored by health care personnel had the greater chances of abiding to their DOT treatment regimen compared with self-administration, which was found to have the highest risk of not complying with their treatment regimen.

DOTS has a significant effect on the treatment success rate in countries that have full DOTS coverage with at least 18% success rate after the implementation of DOTS (Elkomy et al., 2013). Elkomy et al. (2013) recorded 70% regularity among patients receiving their TB medications through DOTS compared with 40% of patients who are self-administered. The authors cited the characteristics of the patient, availability of drugs, communication between patients and their caregivers, side effects, duration and number of medications needed, and economic status of the patient as reasons for poor adherence.

Even though the success of DOTS has been lauded in many quarters, there are still some mixed results regarding its outcome (Anuwatnonthakate et al., 2008). Many studies that were important in the adoption of DOTS were done retrospectively or utilized quasi-experimental designs. In a prospective study, Volmink and Garner (2007) did not find any major difference between DOT and self-administered therapy in terms of cure rate and treatment completion among both active and latent TB patients. There was also no significant difference in recurrence between DOT and self-administered therapy patients (Cox, Morrow, & Deutschmann, 2008). In fact, in some high TB-burdened

countries, such as South Africa, 77% of all recurrences were due to new infections rather than relapse (Charalambous et al., 2008).

Problem Statement

Even though Sierra Leone adopted the WHO-recommended DOTS for the treatment of TB in 1990, the TB burden continues to increase with an estimated prevalence of 574 per 100,000 populations (WHO, 2014). The number of registered TB cases in Sierra Leone almost doubled between 2004 and 2007 (National Leprosy and Tuberculosis Program, 2010). The success rate of TB treatment increased from 79% in 2004 to the high of 86% in 2009, but decreased back down to 79% in 2010 (WHO, 2014). The incidence rate of TB has increased from 252 in 1990 to 310 per 100,000 people in 2014 (WHO, 2016). The fluctuations in the success rate were attributed to lack of compliance with the treatment regimen, lack of drug supply, and the possible development of drug-resistant TB (WHO, 2014).

The current focus of research on the implementation of DOTS in Sierra Leone has been on trends in the success rate of the DOTS program (Kangbai & Koroma, 2013; William, 2010). Williams (2010) observed an improvement in cure rates among DOTS patients due to program expansion, but the author did not consider failure rates and default rates in their investigation. Kangbai and Koroma (2013) reported a high incidence rate, high mortality rates, and a fluctuating default rate among patients undergoing DOTS treatment; however, they failed to explain patient attributes that account for the observed trends.

Although the aforementioned studies have shed light on important findings on trends and success rates of the DOTS program in the treatment and control of TB, I have found no research on patient characteristics that influence treatment outcomes in Sierra Leone. As a consequence, further research was warranted to examine the possible patient characteristics associated with TB treatment outcomes in an effort to address the high incidence and mortality rates despite decades of DOTS implementation in Sierra Leone (Kangbai & Koroma, 2013; National Leprosy and Tuberculosis Program, 2010).

Purpose of the Study

The purpose of this quantitative study was to investigate patient characteristics that affect the successful treatment of TB among TB patients under the DOTS in Sierra Leone. TB treatment outcome is affected by a multitude of factors, such as availability of TB drugs, compliance with the treatment regimen, early diagnosis, the age of the patient, socioeconomic status, HIV prevalence, and stigma (Kangbai & Koroma, 2013). Research on TB treatment outcomes in Sierra Leone is scant, even though there is growing evidence that the fight against the disease remains an uphill battle. In this quantitative study, I investigated the relationship between the age of patients, TB category, and treatment completion. I also examined the extent to which HIV status and gender predict the likelihood of completing TB treatment.

The main outcome of interest in this study was treatment completion. Participants are classified as having completed their treatment if their record shows that they have gone through with their treatment for greater than or equal to 168 days. The dependent variable was binary, with a simple “YES” for treatment completed and “NO” for

treatment not completed. The independent variables that were tested for treatment completion were participant's age, gender, HIV-status, and TB category. Participants' education, marital status, and geographic location were the controlled covariates that were adjusted for in this study.

Research Questions and Hypothesis

The following research questions (RQs) were addressed in this quantitative study:

RQ1: Is there an association between age and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$1: There is no association between age and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_1$1: There is an association between age and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

RQ2: To what extent does gender predict the likelihood of treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$2: There is no difference in the odds of TB treatment completion between men and women among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_1$2: The odds of treatment completion are different for men and women among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

RQ3: Is there an association between TB-case category and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$3: There is no association between TB treatment completion and TB-case category among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_1$3: There is an association between TB treatment completion and TB-case category among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

RQ4: To what extent does HIV status predict the odds of TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$4: There is no difference in the odds of treatment completion between HIV-positive patients and HIV-negative patients among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_1$4: The odds of treatment completion are different for HIV-positive patients and HIV-negative patients among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

Theoretical Background

The theoretical framework that guided this study was Andersen's (1968) behavioral model of health service utilization (Andersen, 1995). This model has been widely used in several studies dealing with factors that affect health service use, including those investigating difference health care systems as well as different diseases. The purpose of the model is to demonstrate how a variety of factors influences health service utilization. The model predicts that health service usage is determined by predisposing factors, enabling factors, and the need for health service utilization (Li, Matthews, Aranda, Patel, & Patel, 2015). Predisposing factors include demographic factors such as age, gender, and race; social factors such education, occupation, and social relationships (family status); and mental factors or health beliefs such as attitude, values, and knowledge about health and health services (Li et al., 2015). Enabling factors are conditions that enable service utilization (Li et al., 2015). They may include access to insurance, family support, and organizational factors such as means of transportation, travel time, and wait time for services. The need for health service usage can be described as perceived need (an individual's perception of his or her health), and actual need as objectively assessed by a professional for medical care (Babitsch, Gohl, & von Lengerke, 2012). Therefore, Andersen's model offers guidance on the characteristics that dictates medical care usage.

Nature of the Study

I used a retrospective, longitudinal quantitative study to investigate patient characteristics and how they affect TB treatment completion among patients enrolled in

the DOTS program in Sierra Leone. In a retrospective study, the outcome of interest is already known, and the researcher traces back to establish a relationship between the outcome and possible risk factors (Frankfort-Nachmias & Nachmias, 2008). In this study, the data were based on patients that already have TB and are registered in TB facilities administering the DOTS program. I selected participants from four randomly-selected DOTS centers representing each of the four political regions of Sierra Leone (the Western Area and the Eastern, Northern, and Southern Provinces).I undertook a retrospective analysis of secondary data that were extracted from follow-up treatment records, hospital registers, and National Leprosy and Tuberculosis Control Program archives on each patient. Information was extracted from all TB cases registered in each of the four randomly selected centers between January 2013 and December 2015.

A retrospective design was appropriate for this type of study because it was cost-effective and time-saving and does not expose subjects to harm due to intervention effects. Retrospective study designs are also suitable for the analysis of multiple outcomes, and more so in the investigation of rare diseases (Aschengrau & Seage III, 2014). I employed both binary and multiple logistic regressions to determine the influence of my independent variables of age, gender, marital status, HIV status, geographic location, and TB category on the dependent variable of treatment completion.

Definition of Key Terms

The following terms are defined as they apply to this study in order to clarify their usage throughout this document. The definitions here might be difference from general

usage. However, it is the intention that there is no ambiguity when it comes to their usage in this document.

General Definitions

Directly-observed therapy short-course/directly-observed therapy (DOTS/DOT): DOTS, or simply called, DOT, is a WHO-recommended method of anti-TB drug administration in which patients receive their daily TB medications under the supervision of a healthcare worker or sometimes an entrusted family member (WHO, 2016). The two abbreviations are interchangeably used in this study.

Smear-negative pulmonary TB: This refers to a situation where two or more initial sputum samples from a patient are negative for acid-fast bacteria, or where one initial positive AFB sputum is found but radiographic abnormalities are consistent with active TB disease determined by a clinician. The person doesn't also respond to broad-spectrum antibiotics in the absence of HIV (Demeke, Legesse, & Bati, 2013).

Smear-positive pulmonary TB: This refers to a situation where one or more initial sputum of a patient are positive for acid-fast bacteria (AFB) or one initial positive AFB sputum plus a radiographic indicative of an active TB disease determined by a clinician (Demeke, Legesse, & Bati, 2013).

Tuberculosis (TB): TB of the lungs (pulmonary TB) or TB of other body organs, such lymph nodes, abdomen, skin, joints, bones, meninges, pleura, and genitourinary tract, otherwise known as EPTB (Endris et al., 2014).

Definition of Dependent Variable

Treatment completion: This is defined as patients who have completed at least 168 doses of their medication (6 months' treatment) and their initial positive sputum converted to negative sputum at the end of the treatment. It also includes those who do not meet this conversion criterion but neither can they be described as having failed treatment. They include patients with sputum-positive and sputum-negative pulmonary TB as well as those with EPTB disease that has been described as free of the active TB disease after treatment.

Definition of Independent Variables

Age: This is defined as the time between the day a person was born and time they were diagnosed with TB expressed in years. In this study, the measurement of age was a categorical variable.

Gender: This is a nominal variable that is defined as the being of male or female.

HIV status: This is defined as having been tested for HIV such that the patient's status is known (positive or negative; CITE). The variable is a nominal variable with two measurement levels.

TB-case category: This refers to the patient category at the start of treatment. The measurement is dichotomized into whether the case is new and nonnew, which includes retreatment and relapse cases.

Definition of Covariates

Education: This is defined as an ordinal variable with four categories: noneducation, some elementary, some high school, and some posthigh school education.

Geographic location: This is defined as one of the four political divisions of the country (Western Area and Northern, Eastern, and Southern Provinces) from where patient data were collected and where patients are assumed to reside during the course of treatment. The variable is measured at the nominal level of measurement.

Marital status: This is defined as being in a relationship at the time of diagnosis. The variable is dichotomized into single and being married.

Assumptions

The conclusion of this study will remain valid based on the fact that the following assumptions hold. It was assumed that the hospital registers and patient visit records from the four regional government hospitals contained data that were representative of all TB cases in the country within the specified period of time. It was also assumed that all cases monitored by the centers were followed and the end points (deaths) recorded. The premise of this assumption may be difficult to ascertain since most deaths are not reported, making it difficult for health workers to ascertain endpoint or conclude loss-to follow-up.

Scope and Delimitation

The main focus of this study was to look at the influence of patient characteristics, such as gender, age, HIV status and TB category, on TB treatment outcome (completion). There are few studies in the literature on Sierra Leone that have addressed this issue, even though studies indicate that TB continues to increase (Kangbai & Koroma, 2013; William, 2010). In this study, I included data only on TB patients registered under the DOTS program at the four regional hospitals between the years 2013 to 2015. Hospital

and patient records outside these facilities and years were included in the study. Since I assumed that the characteristics of the patients in the selected hospitals generally reflected those of the general population, the outcome of the study was generalizable to include the entire TB patient population in Sierra Leone.

Limitations of the Study

In this study, I analyzed secondary data from hospital registers and patient records that were recorded on each TB patient at the four selected regional hospital centers in Sierra Leone. The study was therefore limited to those TB patients registered in those DOTS centers to receive TB treatment. At the time of the study, the data capture and storage system in Sierra Leone was still manual and recorded on hard paper copies instead of electronically. There was a possibility of the occurrence of errors during data collection. It was also possible that patient information may have been lost during storage, especially in situations where patients have more than one patient card. In addition, there was no way to match patient information from previous encounters, as is easily done with electronic data recording and storage. These limitations may have led to loss of vital information and may threaten the validity of the outcome, depending on the magnitude of the loss.

There was also a potential threat to both internal and external validity with respect to the secondary data on study participants that are collected and stored. One of the major threats to validity in this study was the selection of the regional hospitals in question, as well as the selection of samples within the study period in each of these hospitals. This selection may have introduced selection bias, as not all hospital facilities are the same,

nor are the patients who are served in those hospitals. Another threat to internal validity was experimental mortality. Since TB treatment requires a long duration, at least 6 months, some patients may have found it difficult to continue treatment and may have dropped out of the program. In Sierra Leone, where deaths are not always recorded, some of these censored may be erroneously recorded as dead. For those that are able to continue to pass a certain time threshold, mostly after 2 months, may be motivated to do so and thereby improve their treatment outcome regardless of their characteristics. Some patients may also be turned off by the personnel in the treatment center. Changes in such personnel who act as an agent of instrumentation in outcome measurement may have affected changes in the outcome as well.

I addressed the threat to validity in that the four chosen hospitals are the main reference hospitals in each region for the treatment of TB. They receive the bulk of the TB patients, and therefore, were representative of the entire TB population, as fewer patients are treated outside the four facilities. Since only four DOTS centers were selected for this study from the entire country, it was assumed that DOTS program in each hospital, along with patient characteristics, were fairly similar regardless of the location. I addressed sample selection bias by randomly selecting the representative samples from records following simple random sampling technique. Furthermore, since recording errors are random and not systematic, any effect introduced canceled each other out.

Significance of the Study

My findings in this study shed light on the efficacy of the DOTS program as implemented to treat TB in Sierra Leone for decades. The findings fill a gap in the literature by providing information on those patient characteristics that contribute to successful TB treatment outcomes among patients enrolled in the DOTS program in Sierra Leone. The study findings have significant implications for social change policy and practice, being that even decades after the implementation of DOTS, no study has been conducted to investigate patient characteristics among the treatment population that contributes to patient treatment completion. An understanding of the relationship between treatment completion and patient characteristics will help inform decisions, both for policy makers and health professionals involved in the program, to concentrate resources in areas where they may have the greatest impact on TB treatment and prevention. Therefore, the outcome of this study will create positive social change by improving the DOTS program's efficacy. At the same time, the study findings may identify the characteristics of those pockets of patient population who are at high risk of defaulting on their treatment, thereby providing information that can lead to improved national surveillance. Increased monitoring of such groups and providing special attention to them, may improve compliance, and hence, reduce the TB burden in the population.

Summary and Transition

Sierra Leone is among the 30 countries with the highest burden of TB in the world (WHO, 2015). Despite decades of antimicrobial TB treatment under the DOTS program, the incidence of the disease still continues to increase (Kangbai & Koroma,

2013). The government, in collaboration with development partners, has dramatically increased the number of DOTS centers in the country (Kangbai & Koroma, 2013). Despite all these efforts, the government failed to meet the 2015 Millennium Development Goal for reducing the prevalence of TB to half of the 1990 level (WHO, 2016). This failure indicates that availability of DOTS centers alone is not sufficient in reducing the incidence rate, but other factors such as patient characteristics should also be taken into account. In order to better understand the problem, with this study I sought to investigate some of those patient characteristics that may militate against treatment completion, and hence, increase TB transmission and incidence rates. In Chapter 1, I have presented a brief description of the study topic, outlined the problem statement, the purpose of the study, the scope of the investigation, the research questions to be explored, and possible limitations of the study. In the following chapter, I will provide a detailed review of literature in terms of scope, variables of interest, and methodology employed in the various studies.

Chapter 2: Literature Review

Introduction

TB has made a resurgence after many years of decline. This resurgence can be attributed to changes in the social structure in cities, the increase in the prevalence of HIV/AIDS, the cost of TB treatment, and the failure to improve public health programs in most cities (Driver et al., 2005). Anuwatnonthakate et al. (2008) opined that the major barrier to the global control of TB is the noncompliance of patients with treatment and the long duration of the treatment course. The effective treatment of TB requires 6 to 9 months of chemotherapy with antibiotics (Munro et al., 2007). Nonadherence to treatment increases the risk for development of drug-resistant TB, thereby reducing the chances of cure (Maartens & Wilkinson, 2007). Nonadherence may also lead to prolonged infection, development of drug resistance, and increased morbidity and mortality (Getahun, Ameni, Medhin, & Biadgilign, 2013).

In this chapter, I will provide a comprehensive review of the literature that is currently available regarding the present research study - patient characteristics and treatment outcomes among TB patients in Sierra Leone. In order to provide such a basis for the purpose of the study, I will provide a detailed description of the literature search strategy that was used in the review. This was necessary to show that the information included was systematically evaluated for the purpose of providing the most extensive data available. Keywords and terminology were included in order to allow for the replication of this search strategy to further provide validity to the results. In the chapter, I will review selected literature to define and justify the use of the Andersen's behavioral

model of health services utilization. I found this to be relevant to provide the reader with a better basis for understanding the process of the present research as this involves the factors associated with treatment compliance (Li et al., 2015).

The chapter will contain a brief review of the literature associated with the factors influencing the utilization of health care services in general. This review will provide the reader with the most recent findings in the field of research associated with the utilization and compliance of health care treatments. This section will be followed by a review of the literature on the implementation of DOTS in selected African countries including Sierra Leone. This will lead to a general description of the DOT protocol, which will become more directly related to the study as I will present data regarding the studies that relate to research variables (the independent variables of age, gender, HIV status, and TB-case category and the dependent variable of treatment completion).

Finally, as the literature review comes to a close, I will provide support for the research method and design by reviewing previous studies that have utilized similar methods to collect data in health care research. A summary of findings throughout the literature review will then be provided with the most relevant information being highlighted for recollection as the present research continues. This will allow for a reliable transition into Chapter 3 where I will present the methodology of this study.

Literature Search Strategy

For the purpose of this literature review, I used a selection of peer-reviewed journal articles and government-affiliated documents. These documents were accessed electronically through the Walden University Library and Johns Hopkins Medical

Institute websites. The articles were retrieved from academic databases, along with government, and other institutional websites. I searched the ProQuest, PubMed, Medline, Thoreau, Science Direct, Google Scholar, World Health Organization, Center for Disease Control and Prevention, and Ministry of Health and Sanitation of Sierra Leone databases and search engines. Each of these databases and search engines connects to both government and peer-reviewed documents in a way that allows for the use of key terms and arrangement by relevance to the keywords and the date of publication. I omitted duplicate publications from the search, allowing for a more comprehensive assessment of the available literature.

In order to retrieve the most relevant results for this literature review, I selected keywords that would allow for a more direct line of results, and therefore, minimize the necessity to review literature that would not add to this study. These keywords consisted of the following terms: *tuberculosis, tuberculosis in Sierra Leone, directly observed therapy, treatment compliance, self-administered therapy, Tuberculosis and Treatment outcome, National Leprosy and Tuberculosis Program, HIV and tuberculosis, compliance and demographics,* and *Andersen's behavioral model of health services utilization. The words are serach individually and in word combination.*

Inclusion Criteria

I subjected the literature sources selected for review to the following inclusion criteria:

- Literature source was recent having been published within the time period of 2010–2016, with the exception of some very few articles relevant to this study.
- Literature source was peer reviewed or provided by a government source.
- Literature source was written in English.
- Literature source was found to be relevant to the overall research questions of this study.

Exclusion Criteria

In order to compose a literature review with the most accurate and relevant information, the literature sources I reviewed for this study were subjected to the following exclusion criteria:

- Literature source did not meet the inclusion criteria.
- Literature source was repetitive having cited more than five other sources being utilized in the review.
- Sample size of the study did not represent the target population.
- Literature did not provide ample documentation to support the validity of the study.

Conceptual Framework

I chose Andersen's behavioral model of health service utilization as the theoretical framework to guide this study (Andersen, 1995). This model has been widely used in several studies dealing with factors that affect health service use. It has been used

in studies investigating difference health care systems as well as different diseases. The purpose of the model is to demonstrate how a variety of factors influences health service utilization. The model predicts that health service usage is determined by predisposing factors, enabling factors, and the need for health service utilization (Li et al., 2015). In order to provide the most comprehensive understanding of the selection of this theoretical framework, I found it necessary to select literature that both defined the components of the framework and that which has used this theoretical framework in an effort to show the application of these components in a practical manner. Therefore, this section will be divided between those two foci, respectively.

According to Anthony et al. (2007), the expanded version of the behavioral model of health service utilization consists of four conceptual categories that allow for a better understanding of the likelihood of patients to be compliant with the treatment protocol that is selected for their illness: traditional predisposing factors, enabling factors, need factors, and vulnerable predisposing factors. Anthony et al. explained that the first of these, the traditional predisposing factors, involve demographic variables, while the second category enabling factors are more related to socioeconomic variables such as medical insurance availability. The third category, need factors, are based on the necessity for other medical care such as a terminal illness or disability, and the final category, vulnerable predisposing factors, are categorized by the psychosocial issues such as support and behavioral variables (Anthony et al., 2007). In their article, Anthony et al. provided a basis for comprehending the substructure of the behavioral model of health service utilization.

Bergman, Haley, and Small (2011) further explained that Anderson's behavioral model of health service utilization can be applied to all areas of health care services, including mental health and bereavement services, as the factors associated with utilization are applicable determinants in these areas in as much as they are applicable to disease maintenance treatment protocols. Bergman, Haley, and Small provided additional defining characteristics of the term *predisposing* as being characteristics which

> present prior to the onset of need, deter or predispose individuals from using health care services. Examples include demographic characteristics (e.g., age), aspects of social structure (e.g., race), and health beliefs (e.g., perceptions and knowledge of the disease and medical care) (p. 532).

Presenting a study that was conducted longitudinally with multiple sites for sampling, Bergman, Haley, and Small found that the geographical differences were not as highly associated with the utilization of bereavement services so much as were the belief sets, found to be related to religiosity, and the presence of other mental health conditions. This information was noted to be helpful to mental health professionals in assessing the needs of the mourners and to structuring bereavement services in a manner that would be acceptable based on these predispositions (Bergman, Haley, & Small, 2011).

In a recent study, Li et al. (2015) also used Anderson's behavioral model of health service utilization to examine the association between negative experiences in the health care setting that influence the utilization of health care services among sexual minority African American women. The model helped them in understanding how predisposing

(young age), enabling, and need factors predicted negative experience. They also found that patient and health care factors were associated with low health service utilization.

Kim, Jang, Chiriboga, Ma, and Schonfeld (2010) also used Anderson's behavioral model of health service utilization in a recent study regarding the utilization of mental health services in the elder Latino and Asian immigrants. As the study necessitated, the framework was adapted to include the components of (a) predisposing factors, (b) enabling factors, (c) need factors, and (d) mental health service use outcome. However, the primary guidance of the study followed the framework as presented by Anderson and maintained that the factors were substantially valid for the purpose of obtaining adequate data regarding the utilization of these health care services. Kim et al. explained that the use of this framework allowed them to use Anderson's findings as a baseline for adding to the knowledge base to be applicable to all health care services. Kim et al. found that for elder immigrants, the need factors were more often associated with the decision to not utilize mental health services and explained that this data is in support of culturally specific mental health services, noting possible implications for other areas of health care services as well (such as the utilization of DOTS program in the treatment of TB).

In this section, I provided the basis for the use of the behavioral model of health service utilization in multiple areas of health care service studies. It has been shown that predisposing factors can be viewed as demographic variables such as age, gender, race; social factors such as education, occupation, and social relationship (family status); and mental variables or health beliefs such as attitude, values, and knowledge about health and health service (Bergman, Haley, and Small (2011)). Enabling factors are conditions

that enable service utilization. They may include access to insurance, family support, and organizational variables such as means of transportation, travel time, and wait time for services. The need for health service usage can either be described as perceived need as an individual's perception of his health, and actual need as objectively assessed by a professional for medical care (Babitsch et al., 2012). Therefore, Andersen's model offers guidance on the characteristics that dictates medical care usage such as those of the DOTS program in the treatment of TB.

Factors That Influence the Utilization of Health Care Services

I devoted the previous section of the literature review to the conceptual framework to provide the reader with an introduction that ties the study to a grounded theoretical framework. In this section, I will discuss the general factors that are associated with or contribute to the use or neglect of health care services by patients in all areas of medical services. I feel that it was necessary to provide a more detailed analysis of the literature available that better defines these factors.

In an attempt to investigate factors that affect health services utilization, Ragnarsson et al. (2011) explored the factors or barriers that hinder sexual behavioral change among patients receiving antiretroviral treatment. The authors identified gender as being a factor in noncompliance with a special emphasis on the male gender. Ragnarsson et al. suggested that men suffer from more chronic illnesses than do their female counterparts yet have developed beliefs and behaviors that prevent them from either utilizing the health care services and/or adhering to the recommended treatment protocol. Ragnarsson et al. indicated that this correlation is two-fold as the beliefs and

behaviors place the males at a higher risk for chronic illnesses while the noncompliance prevents them from receiving adequate symptom control or a cure for the illnesses that they suffer from (whether due to the beliefs or behaviors or stemming from other external factors). Notably, Ragnarsson et al. explained that the ethnicity, economic status, educational level, sexual orientation, and familial and cultural beliefs regarding masculinity are also well established as being factors in the gender differences in compliance to medical treatment protocol with particular emphasis on the risks associated with HIV.

De Joode, van Boxtel, Verhey, and van Heugten (2012) continued the discussion regarding the societal and cultural beliefs as being a factor in determining the compliance to health care treatment protocols and the utilization of health care services that was discussed by Ragnarsson et al. (2011) as the researchers noted that individual behaviors, no matter how independently processed, are inevitably linked to the familial and cultural teachings that have been communicated from infancy. For instance, deJoode et al.stated that the use of technology, for some generations, has been considered to be absent from the natural progression of the human condition and therefore find that the use of technology in the medical field is also against the laws of nature. De Joode et al. explained that the perception of technology in generations or regions that have not had excessive access to technology is generally related to the fear and predisposition to avoid the use of health care services that may require or indicate the use of technology as a product of being afraid of the unknown.

Additionally, Ackerman, Ademi, Osborne, and Liew (2013) discussed the factors related to socioeconomic status that impact the utilization of and compliance with health care services. Specifically, Ackerman et al. addressed those among the lowest socioeconomic classes who live not only in poverty but without adequate housing who are in need of mental health services. Because of the vulnerability of this class of citizens, there is an increased risk associated with homelessness and other concerns such as mental health, substance use, residential history, competing needs, and victimization. Independently, all of these additional concerns has been discussed as factors associated with noncompliance. However, when combined, the population of homeless individuals is found to be among the highest in need but lowest in utilization. Ackerman et al. attributed this disparity to other factors including the accessibility of insurance, the ability to have transportation to the health care facilities, and the demands of meeting their basic needs over the belief that the health care compliance is necessary to their wellbeing.

Johnson, Moser, and Garwood (2013) agreed with Ackerman et al. (2013) regarding the combination of multiple factors as being an indicator for noncompliance, adding that the health care literature is more accessible to those in the higher socioeconomic statuses than to those who are impoverished or homeless. Johnson et al. noted this disparity especially in regards to mental health information as many of the available sources of literature are found at the offices of family physicians which are not often frequented by the homeless or those in poverty due to the limited access to transportation and medical insurance. Reeves et al. (2015) explained that this leads to an increase in the occurrences of undocumented cases of tuberculosis and serves to eliminate

the potential for medical treatment interventions and health care utilization. Other forms of literature that may help a patient to recognize their symptoms and prepare them with questions regarding these symptoms and treatment options can be found in mass media, access to which is also limited for those with lower socioeconomic status. Johnson et al. warned that this limited information leads to misconceptions and often serves to confirm the belief sets that have prevented the utilization of health care services from the onset of these symptoms.

Ameigh, Semler, Lebkuecher, and Scanlan (2015) further explained these factors, along with numerous others, that show the average noncompliance rate to be approximately one quarter. The research found that noncompliance was more often viewed in the maintenance of medication regimens and the continuation of ongoing visits to the physician in regards to illnesses such as diabetes and sleep disorders. Ameigh et al. noted that demographic differences were not as notable as were the types of disorders for which the patients required medical treatment, and that the more severe the illness, the higher the research found the compliance to be. Nonadherence, especially in areas where resources are limited, and the medications are difficult to obtain, is viewed as being wasteful and socially irresponsible as the increased burden on the society can be witnessed in the health depletion of the noncompliant patient as well as in those who are not able to access medication due to the noncompliant patients having been given the necessary resources (Weibing et al., 2015).

Vijay et al. (2010) explained that the predictive factors associated with noncompliance can aid in preventing drug resistance, relapse, death, and treatment

failure. In order to ensure adequate utilization of available resources and that the social burden of noncompliance does not extend beyond the realm of acceptability, Vijay et al. recommended continued research as to the factors associated with noncompliance. They also recommended continued ability to evolve and adapt the programs that are intended to encourage compliance, ensure proper use of the researchers, and improve the overall outcomes of treatment for most patients.

Within this section of the present research I have provided the reader with a more in-depth description of the types of factors that are involved in the decision of the patient to either avoid medical services or to not adhere to the medical treatment protocol recommended by health care professionals. I have also attempted in this section to provide some examples that lend to the understanding of why individuals who are facing significant health issues and/or fatality due to their noncompliance continue to exhibit this behavior. Noncompliance to medical treatment protocol by individual patient can result in the limitation of resources for an entire population. Next, then, this literature review examines health care utilization by more specific populations.

Literature Related to Directly Observed Therapy Short-Course (DOTS) and Variables of Interest

In this section I focused on directly observed therapy short-course as it applies to the utilization of and compliance with health care services. It will also focus on literature that is related to both independent and dependent variables of interest in this research.

Directly Observed Therapy Short-Course (DOTS)

DOTS an international treatment protocol with a strategy comprised of five components: political commitment by national governments, improved laboratory facilities with quality sputum-smear microscopy capabilities, regular supply of anti-TB drugs, direct observation of each patient swallowing their medications under a health care worker, and standardized recording and reporting system for patient and program success (Pasipanodya & Gumbo, 2013). Duwell et al. (2013) noted that directly observed therapy differs from the traditional use of self-administered therapies in that the patient is given the medication, or observed in its administration, to ensure that the patients receive the proper dosage at the proper intervals with the compliance concerns being restricted to the utilization of this service whereas the self-administered therapies rely on the ability of the patient to administer the medication and the willingness of the patient to adhere to the schedule without the accountability that is entailed in the directly observed therapies. The success of DOTS in increasing compliance, reducing the number of new cases, and preventing the development of drug-resistant TB has been widely publicized (Hsien-Ho, et al., 2015; Obasanjo, Shields, Coggin, Chaisson, & Glass, 2012). Duwell et al. found that the outcomes for patients were significantly improved by utilizing directly observed therapy when compared to the use of self-administered therapies.

Khogali et al. (2014) discussed the use of self-administered therapies for the purpose of treating tuberculosis in rural Ethiopia. The researchers explained that the participants were given adherence training and communication in order to promote compliance with medical treatment protocol. Utilizing patient follow-up and

communication techniques, Khogali et al. referred to this protocol as a modified direct observation therapy with an adaptation for a self-administered therapy. This was found to be more effective in rural areas whereas access to a more sustained direct observation therapy facility was limited than was the more rigid direct observation therapy as the patients were not limited to their transportation access but were granted the added support that would not be present in a traditional self-administered therapy. This was significantly a beneficial study as many of the patients in Ethiopia are in rural areas, and the compliance in these regions has been reported as being less than adequate for treating tuberculosis (Khogali et al., 2014).

Bruce et al. (2012) claimed that the directly observed therapies are superior to the self-administered therapies and also added that the former keeps many of the factors that are associated with noncompliance and avoidance of medical services from surfacing in a manner that prevents the best possible outcome for the patient. In fact, Bruce et al.found that the experience level of the individual in relation to how to administer the medication, the socioeconomic status of the individual patient, and the demographic background of the patients did not significantly influence compliance to TB treatment when utilizing the directly observed therapy method of administering necessary medication. This shows that, when patients are given the scenario to be held accountable for their compliance with the medication treatment protocol, they can actually move beyond the barriers to their health and the disparities between races, genders, and socioeconomic statuses can be dissolved in a clinical setting (Gärden et al., 2014).

Beckman (2013) added that, in regard to the social responsibility of noncompliance, there is a significant concern about the costs associated with the directly observed therapy methods. Using a study related to mental health services, Beckman claimed that self-administered therapies are more cost effective when considering the personnel required to administer the treatments, the occurrences of noncompliance, and the rise in health care insurance costs that are then dispersed into the general population as the directly observed therapies are much more expensive than the self-administered therapies (Lunte, Thierry, & Joel, 2015). However, the concern of the noncompliance risks associated with the self-administered therapies must also be evaluated in the context of valuable resources and the ability of those who will be compliant also to have access to the necessary medications (Fitzpatrick et al., 2015).

Gender, Age, TB Category, HIV Status and TB Treatment completion

The successful completion of tuberculosis treatment is not only dependent on the implementation of a TB treatment program, but also on multiple factors. These factors include patient age, time of presentation for diagnosis, prevalence of HIV, socioeconomic status, poor compliance, access to health care services, substance abuse and drug resistance (Demeke et al., 2013; Gelmanova et al., 2007; MOHS, 2010; and Williams, 2010).

Demeke et al. (2013) undertook a study to assess the trend of TB and treatment outcomes among patients that attended the Gambella Regional Hospital in Ethiopia. The authors found that the treatment success rate (TSR) was significantly associated with gender, age, and year of enrollment of the patient in the program. The study demonstrated

a higher treatment success rate among females relative to males. Higher default and death rates were observed among males than females. The treatment success rate was inversely proportional to age. The age 014 years had the highest TSR (72%), and > 64 years had the lower TSR (44%). However, they did not establish any statistically significant association between treatment success rate and forms of TB, patient category, and smear result. The death rate among TB patients undergoing treatment was significantly associated with age and year of enrollment in the program.

A similar study by Syed (2014) attributed a significant percentage of TB cases to noncompliance, and multidrug resistance as the patients do not continue with the regimen through the self-administered therapies and therefore the disease becomes resistant and additional protocols are required in order to gain the same level of success as would have been achieved should the patient had been compliant or been involved in a directly observed therapy. The study concluded among TB patients, that age below 60 years, illiteracy, rural residence, and extrapulmonary TB negatively impacted the treatment success rate; and was found to be significantly associated with treatment failure among TB patients.

Getahun, Ameni, Medhin, and Biadgilign (2013) investigated treatment outcomes among 6450 TB patients in Ethiopia. Among these, 3147 were males, and 3433 were females. The study shows that 64.6% completed treatment, 18.1% were cured, 3.7% died, 5.1% defaulted, 0.4% failed treatment, and 8.2% were transferred out to other centers. The overall treatment success rate was observed to be 82.7%. Getahun et al. did not find any statistically significant relationship between gender and treatment success rate.

However, they did conclude that year of enrollment and treatment center were significantly associated with treatment success rate.

The authors explained that tuberculosis is more isolated in the lesser developed areas of Ethiopia that have yet to reach the level of medical compliance of their more developed counterparts around the world. However, the historical cohort study that is presented by Getahun et al. (2013) suggested that this trend may be alleviated through the continued adherence of directly observed therapies so long as these remain available, and the information regarding these practices is sufficiently delivered to all individuals across the region.

Gadoev et al. (2015) reported a similar treatment success rate of 83% in their study to examining factors associated with unfavorable TB treatment outcomes of patients enrolled in the directly observed therapies in Uzbekistan. However, the authors noted that there was significant disparity among the more vulnerable populations and that there is a need to improve TB services for such groups. The findings showed that death and loss to follow-up among TB patients were associated with being older male (> 55 years), previously treated for TB, living in urban settings, experiencing joblessness, having sputum positive pulmonary TB (SPPTB), and being HIV positive. Loss to follow-up and death were not significantly associated with adolescence or having EPTBdisease. Treatment failure was also associated with urban residency, adolescence, joblessness, previous history of TB, HIV-positive status, and having positive sputum smear. This further elaborates on the factors established in the conceptual framework section of the present literature review as the combination of various factors was highly

indicated as being an increased predictor of noncompliance and unsuccessful rates of treatment (Blank, 2012).

The majority of the studies above established a significant association between treatment outcome and gender, age, residence, type of TB and HIV status (Demeke et al., 2013; Gadoeve et al., 2015; and Syed, 2014). However, in a retrospective study to assess treatment outcomes and associated risk factors, Endoris et al. (2014) did not find any significant association between sex, age, residence, HIV status, type of TB and successful TB treatment. Among the 417 study subjects, 94.8% had a successful treatment out (75.5% completed their treatment, and 19.3% were cured). The remaining 5.2% had unfavorable treatment outcomes, with a 3.4% death rate, a 1.2% failure rate, and 0.5% default rate.

The incidence rate of TB infection has been exacerbated by the advent and spread of HIV. Jemal et al. (2015) explained that coinfection with HIV has created a scenario that further hinders the success of treatment protocols for these patients. The study revealed that 20% of the 2,970 patients undergoing TB treatment were co-infected with HIV. It also shows that coinfection with HIV and being male were significantly associated with unsuccessful TB treatment. This coinfection together with the multidrug resistance have been noted to decrease the success rate of the treatment protocols and increased the occurrences of deaths related to the onset of tuberculosis.

Gao, Zheng, and Flu (2013) conducted a similar study to determine the worldwide prevalence of HIV/TB coinfection. Gao et al. carried out a systematic and meta-analysis of existing literature to determine the prevalence of TB and HIV coinfection worldwide.

They identified 47 studies covering HIV/TB coinfection with a total sample size of 272,466. The results of the meta-analysis showed an estimated TB/HIV coinfection between the ranges of 2.93% to 72.34%. There was substantial heterogeneity in the prevalence of TB/HIV co-infection across regions. The prevalence of TB/HIV coinfection was 14.84%, 17.21%, 20.11%, 25.03%, 31.25%, in the *U. S.*, Asian countries, European countries, Latin-American countries, and African countries respectively. The prevalence of TB/HIV coinfection was higher in studies in which TB diagnosis was made by chest radiography, and HIV was diagnosed by blood analysis than studies in which diagnosis was made by other methods. Coinfection of TB/HIV was also higher in countries with high prevalence of HIV in the general population than those with lower HIV prevalence in the general population.

Literature Related to Methods and Design

As this researcher has stated, the present research utilized a retrospective quantitative study to investigate patient characteristics and how it affects TB treatment outcomes among patients enrolled in the DOTS program in Sierra Leone; therefore, it is necessary to provide evidence supporting the use of this methodology in the present study. In a retrospective study, the outcome of interest is already known. The researcher traces back to establish a relationship between the outcome and possible risk factors (Frankfort-Nachmias & Nachmias, 2008). In this study, the data were based on patients who already had TB and are registered in TB facilities administering DOTS program. Participants were selected from four randomly selected DOTS centers representing each of the four political regions of Sierra Leone (Western Area and Eastern, Northern, and

Southern Provinces). Therefore, in this section I provided information supporting this methodology and allow for a detailed understanding of the components involved.

The qualifier "retrospective" is assigned to the present study because of its use of historical documents. El-Masri (2014) explained that the documents that are utilized for a retrospective design must be validated and substantially supported by external evidence in order to provide validity to the findings of the study. Garrison, Anderson, and Archer (2010) go on to state that retrospective qualitative research studies have become more prominent in the age of modern technology, where various historical documents can be located through a search engine and the available supporting literature has become increasing simplistic to locate. However, Garrison et al. also warned the researchers to validate all information, as it is also much more simplistic for fraudulent accounts to be integrated with legitimate sources of literature.

In regards to the quantitative approach to data collection and evaluation, Quick and Hall (2015) noted that this approach prevents ambiguity in the presentation of the findings, diminishes the potential for biased results, and allows for the statistical analysis of the data to be conducted, evaluated, and presented with visual aids that allow for a rapid assessment of the findings. Quick and Hall noted that in a retrospective study, it is important to be able to provide such statistical data in order to show the relevance of the historical documents as they pertain to the present state of the research and additional values of variables that are being assessed alongside these documents. Bannon (2015) added that the quantitative approach allows for the definition of missing data and the

presentation of the existing data in relation to this definition. Table 1 below is a summary of cross-sectional studies included in this review.

Table 1

Evidence Table

Author(s)	Method/design *N* (sample size)	Measures	Statistical method	Findings
Sunday, et al. (2014).	Retrospective N = 965	patient's age, sex, address, tuberculosis type, and treatment outcome	Descriptive statistics, bi and multivariate Logistic regression, Chi-square	965 patients seen, 304 (33.3%) were cured, 477 (52.2%) had completed treatment given an overall treatment success of 85.5%, 87 (9.52%) died, and 36 (3.94%) were transferred out while 1 (0.01%) failed treatment. Location and treatment category were significantly associated with favorable treatment outcome
Syed, M. A. (2014)	Prospective observational study N = 609	Age, TB category, location, education, treatment completion, cured, default, relapse, and transferred.	Descriptive statistics , Chi square	76.2% were cured, 59% completed treatment among smear negatives, and 36%) in extra-pulmonary case. 24.3% defaulted, 2.6% relapsed, 2.1% transferred out, and 1.8% died among hospitalize patients. Age <60 years, extra-pulmonary TB ($p = 0.0003$), rural residents ($p = 0.0000$), and illiteracy ($p = 0.02$) were significantly associated with failure of treatment among TB patients.
Hamusse, et al. (2014)	Retrospective quantitative study N = 14,221	IVs: Area of residence, age, sex, HIV status, TB patient category, treatment regimen DV: Treatment success	Descriptive statistics, bi and multivariate Logistic regression, Chi-square	Expansion of DOT increase treatment success rate, decrease death and default rates, Aged 25-49, and ≥50 years, re-treatment cases, and TB/HIV co-infection were associated with unsuccessful treatment outcomes
Getahun, et al. (2013).	Retrospective quantitative cohort study N = 6450	IVs: Age, sex, location of center, type of TB, type of treatment, year of enrollment. DVs: treatment outcome	Binomial logistic regression	18.1% were cured, 64.6% completed treatment, 3.7% died during follow-up, 5.1% were reported as defaulters, 0.4 failure and 8.2% were transferred out to another health institution. Treatment center and year of enrollment were significantly associated with treatment success.

(*Table continues)*

Author(s)	Method/design N (sample size)	Measures	Statistical method	Findings
Vijay, et al. (2010)	Case-control N = 1374 (687 cases and 687 controls)	IVs: Alcoholism, illiteracy, Knowledge about TB, commitment, patient-provider interaction, support DV: default	Univariate and multivariate logistic regression	Alcoholism, illiteracy, having other commitments during treatment, inadequate knowledge of TB, poor patient-provider interaction, lack of support from health staff, having instances of missed doses, side effects to anti-TB drugs, and dissatisfaction with services provided were independently associated with default
Demeke, et al. (2013)	Retrospective study N = 2303	IV: sex, age, year of enrollment, forms of TB, patient category, smear result DVs: treatment success rate (TSR), death and default rates	Chi-square, univariate and multivariate logistics regression	Gender, age and year of enrollment of TB patients were significantly associated with TSR ($p<0.05$). However, forms of TB, patient category, and smear result were not significantly associated with TSR ($p>0.05$). Age and year of treatment of TB patients were significantly associated ($p<0.05$) with death rate. Year of enrollment was significantly associated with defaulted TB patients ($p<0.001$)
Endris, et al. (2014)	Five-year retrospective cohort study N = 417	IVs: sex, age, residence, type of TB, HIV status DVs: successful treatment, death, and default rates	Bivariate and multivariate logistic regression	379 (94.8%) patients had successful treatment outcome (302 complete treatment and 77 cured). The overall death was 3.4%, default rate 0.5%, and failure rate 1.2%. No significant association between successful TB treatment outcome and sex, age, residence, type of TB, HIV status, were observed
Kurt, et al.(2012)	Retrospective study N = 1,776	IVs: sex, urban vs rural, DV: TB incidence rate	Chi-Square Linear-by-Linear Association analyses. Mantel Haenszel Test	New case TB rate increased significantly with age every year; there was a positive correlation between age and TB rate in all years TB development risk was estimated to be the same in urban and rural areas

*(*table continues*)*

Author(s)	Method/design N (sample size)	Measures	Statistical method	Findings
Gadoev et al. (2015)	Retrospective study N = 107,380	IVs: socio-demographic and clinical factors. DVs: lost-to-follow-ups, deaths and treatment failures	Univariate and multivariate logistic regression	Age >55 years, HIV-positive, sputum smear positive, previously treated, jobless and location were associated with death Being male, previously treated, jobless, living in an urban area, and living in certain provinces were associated with lost-to-follow-up Having smear positive PTB, being an adolescent, being urban population, being HIV-positive, previously treated, jobless and residing in particular provinces were associated with treatment failure
Jemal et al., 2015	Retrospective study N = 2970	IVs: Sex, age, HIV status, DVs: death, successful treatment, default and treatment failure	Bivariate and multivariate logistics regression	Low treatment success rate (TSR) of TB patients and a declining trend of TSR Co-infection with HIV and being male correlated with poor treatment outcomes
Tolosie, & Sharma, (2014)	Retrospective N – 826	IVs: age, body weight at initiation of treatment, TB patient category, and HIV status DVs: treatment survival	Kaplan-Meier plot, Logrank test, univariate and multivariate Cox proportional hazards tests	Age, TB patient category, HIV, and age by HIV interaction were significant risk factors associated with death status in TB patients
Kangbai, & Koroma, (2013)	Retrospective N = 2,958	Treatment success and incidence rates	Descriptive statistics	Incidence and treatment success rates increased
Williams, (2010)	Retrospective N = not indicated	IV: directly observed treatment short-course (DOTS) DV: notification and treatment cure rates	Descriptive statistics	Weak correlation between treatment cure rate and DOTS expansion

Williams (2010) investigated the impact of DOTS on the TB treatment cure rate in the postconflict period of 2002 to 2005. Data were retrospectively collected from district TB registers and the annual TB reports for 2002 to 2005. The registers contained summary data on TB cases compiled from treatment cards, and laboratory registers. The collected data contain demographic information such as age, and gender, as well as treatment outcome such as cured, completed treatment, defaulted, failed, and died. However, the authors considered only cure rate as relevant in assessing program success.

The results show that there was no significant trend observed for infectious TB incidence during the program implementation period between 2002 through 2005. The lowest number of infectious TB cases was reported in 2003. There was a decline in the number of reported cases during the third quarter of each month, which corresponded to the peak of the rainy season. The expansion of the DOTS coverage improved DOTS coverage and the treatment cure rate. However, the association between treatments cure rate and DOTS coverage was weak.

A retrospective study was undertaken by Kangbai and Koroma (2013) to examine the annual pulmonary tuberculosis (PTB) incidence rates in Sierra Leone between 1992 and 2010. A total of 2,958 patients, mostly adults between the ages of 15 to 65 years old, were diagnosed and treated across various DOTS centers in the country. There were 1,881 males and 1,077 females. All patients were sputum positive for pulmonary TB and enrolled for PTB treatment in all 13 regional Germany Leprosy Relief Association's (GLRA) diagnostic and treatment centers in Sierra Leone.

The results of the study revealed that the incidence of PTB increased significantly from 233 per 1,000,000 populations in 1992 to 682 per 1,000,000 populations in 2010. Meanwhile, the treatment success rate rose concomitantly with incidence rate from 75% in 1994 to 86% in 2010. The mortality rate declined slightly from 27% in 1992 to 21.8% in 2010.

It is evident from the studies by Williams (2010) and Kangbai and Koroma (2013) that the incidence rate of TB continuous to increase despite decades after the implementation of the DOTS program. However, the studies are descriptive in nature without any inferential statistics to evaluate the significance of the findings. Therefore, the results cannot be extrapolated to include the general population. These articles are relevant to my study, as they provide its epidemiological basis. It is evident that patient compliance to treatment and those factors that contribute to treatment success or failure were not investigated in either study. The aim of my study is to contribute to the gap in the literature and provide sound scientific evidence for patient compliance to treatment as contributing to treatment success rates.

Tolosie and Sharma (2014) conducted a retrospective study to investigate the factors that affect the survival of patients enrolled in a DOTS TB control program. Data were obtained from medical records of 826 patients. Among the total participants, 105 died (12.71%), and 712 were censored (87.29%). The authors used Kaplan-Meier (KM) plots, logrank tests, and Wilcoxon tests to assess the survival patterns of patients with respect to age, gender, body weight at the start of treatment, TB patient category, type of TB, and HIV status. The KM plots show that there were differences in survival curves

with respect to age category, initial weight at treatment, TB patient category, and HIV status. However, gender, smear result, and type of TB did not show significant differences in their survival patterns. This was confirmed by the logrank and Wilcoxon tests to test the level of significance of the observed differences in survival patterns. The tests confirmed that there were significant differences in survival experience among patients in different age categories, body weight at initiation of treatment, TB patient category and HIV status. However, no significant differences were observed with respect to gender, smear result, and type of TB. Further analysis using the Cox proportional hazards regression indicated that age, TB patient category, HIV status, and interactive effect of age and HIV were significant factors associated with death among TB patients. However, initial body weight at the start of treatment, smear result, and type of TB did not significantly impact patient survival undergoing TB treatment.

Valadas et al. (2013) carried out a retrospective study to investigate TB/HIV or malaria co-infection for patients admitted during 2007 at a large hospital in Luanda, Angola. Data were collected on patient demographics, HIV status, and malaria diagnosis, TB treatment method, and mortality data. A total of 4,666 patient's data were analyzed from hospital records. There were 1,906 (40.8%) patients diagnosed with TB, mostly adults (> 14 years); among which 1,111 (58.3%) were male. The number of new cases was 441 (54.4%), 220 (27.2%) were relapsed cases, 29 (3.6%) were a failure, and 120 (14.8%) were considered reappeared. About 604 (99.7%) out of 606 children (< 14 years) were diagnosed with TB. A total of 712 TB patients (37.4%) were diagnosed with HIV, and 714 of 1,906 TB patients (37.5%) were diagnosed with *Plasmodium falciparum*

malaria. Among the TB patients, 290 died (15.2%), of which 27 were HIV positive, and three had malarias. The results show that the rate of TB/HIV coinfection was high (37.4%) among TB patients. The mortality rate among TB patients was found to be 15.2%.

Hamusse, Demissie, Teshome, and Lindtjorn (2014) investigated a 15 year trend in treatment outcomes among patients with pulmonary smear-positive tuberculosis (PTB+) registered between 1997 and 2011 in Arsi, Central Ethiopia. The area of Arsi has one hospital and 73 health centers scattered through 23 districts. The population of the area was 3.1 million. A retrospective study was employed to audit TB treatment outcomes for PTB+ cases registered between September 1, 1997, and August 31, 2011. A total of 14,221 cases were evaluated. From this figure, 11,888 (83.6%) were successfully treated across the region. The rate of treatment success ranged from 69.3 to 92.5%, default rate ranged from 2.5% to 21.6%, the failure rate from 0% to 3.6%, and the death rate from 1.6% to 11.1%. The trend of treatment success rate increased from 61% to 91% with an increase in DOTS coverage from 18% to 70% over the study period. Both default and death rates decreased from 29.9% to 2.1%, and 8.8% to 5.4% respectively over the 15-years period. Logistic regression analysis of the data indicated that patients age >25 years, re-treatment cases, TB/HIV co-infected cases, and patients with no contact were associated with unsuccessful treatment outcomes. The authors opined that the low treatment success rate among retreatment cases could be attributed to the high incidence of MDR-TB among the group.

Sunday et al. (2014) provided the results of a retrospective study involving 965 patients who tested positive for tuberculosis and were enrolled in a direct observation therapy program. The results showed an 85.5% success rate of completing the treatment with 477 patients having completed their treatment (52.2%), 304 cured (3.3%), 87 died (9.52%), 36 (3.94%) were transferred out, and 0.11% having failed to complete the treatment. Logistic regression analysis by the authors showed that location of the treatment center and treatment category was significantly associated with favorable treatment outcomes.

The studies by Gao et al. (2013), Valadas et al. (2013), Sunday et al. (2014), and Hamusse et al. (2014) are relevant to my studies in that they attempt to investigate those patient-associated factors that influence TB incidence and treatment success rate using quantitative retrospective cohort studies.

Critique of Methodology in Selected Articles

A review of the studies from Table 1 above shows that majority of them used retrospective study design with the exception of Vijay et al. (2010) which used case-control study design. A variety of statistical methods were used ranging from descriptive statistics (Kangbai & Koroma, 2013; Williams, 2010) to inferential statistics such bivariate and multivariate logistic regression (Endris et al., 2014; Gadoev et al., 2014; Getahun et al., 2013; Jemal et al., 2015; Sunday et al., 2014), chi-square, (Demeke et al., 2013; Hamusse et al., 2014; Syed, 2014), Kaplan-Meier survival analysis, and multivariate Cox proportional hazards analysis (Tolosie et al., 2014).

Table 1 reveals that there were variations among the studies with respect to sample size used. The sample size of the studies ranged from 417 (Endris et al., 2014) to 107,380 (Gadoevet al., 2015). With the exception of three studies (Gadoevet al., 2015; Getahun et al., 2013; Hamusse, et al., 2014) the sample sizes in all the studies reviewed were between 417 and 2,958 participants. For example, Endris et al. (2014) conducted a retrospective study involving 417 participants from a DOT center in Ethiopia. The measures examined were: sex, age, residence, type of TB, HIV status, successful treatment, default, and death rates. Even though the authors observed a 94.8% treatment success rate, they did not observe any statistically significant association between TB patient characteristics and unsuccessful treatment outcome using multivariate logistic regression analysis. The weakness of this study is that no covariate was investigated to determine their contribution to treatment outcome. It is therefore not surprising that the authors failed to establish any association between patient factors and treatment outcome. Another weakness is that the study was undertaken in only one DOTS center. As a result, the outcome of the study cannot be extrapolated to the general Ethiopian population.

Sunday et al. (2014) used a retrospective study design with 965 participants to investigate treatment outcomes among TB patients at a DOTS center in southwestern Nigeria. The parameters investigated were- patient's age, sex, location, type of TB and treatment outcome. They used descriptive statistics and bivariate and multivariate logistics regressions to analyze their data. This study is prone to bias, as a large proportion of the data was eliminated because of incomplete information on data points. About 33.5% (486) of data were deleted as a result missing information. Another

weakness is that the authors did not control for covariates, as there was no information on education, occupation, housing, and other socioeconomic variables in the registry.

The only two studies that I found on the subject done in Sierra Leone as shown in Table 1 did not use any multivariate method. The study by Kangbai and Koroma (2013) was a large population-based study with a sample size of 2,958. The sample size was sufficiently large enough with a longer period of implementation (18 years) for valid analysis. However, the study conducted by Williams (2010) did not include any sample size. The author only presented summary statistics indicating proportions of treatment outcomes. It is, therefore, difficult to replicate the study thereby raising questions about its validity. In both studies, the major weakness was their over-reliance on descriptive statistics whose output does not permit generalization of the outcome on the general population from which the samples were drawn. In addition, the authors in both studies just focused on the program success rate without any reference to patient factors that may influence the treatment success rate. They also failed to address any confounders that they controlled that might affect treatment outcomes.

It is apparent from Table 1 that majority of the studies entailed retrospective study design using secondary data. The two main country-specific studies on TB in Sierra Leone did not use inferential statistics, which makes the generalization of the outcome on the population impossible. Most of the studies did not include any discussion of how sample and effect size were determined and chosen. Sample size calculations and sample selection are crucial, as they help in replication of the study for validity purposes. It will also help in reducing Type II errors in power analysis. The lack of measurement of

confounders in the analysis of exposure variables in the studies above introduces the likelihood of bias in epidemiological studies. Therefore, my research will attempt to investigate the effect of patient factors such as age, HIV status, gender, and TB category that influence treatment outcomes among TB patients, which were not addressed by the studies mentioned in Table 1 above. The study will also attempt to control for other covariates such as education, geographic location and marital status that might affect the study outcome.

Summary and Transition

In Chapter 2, I provided a comprehensive review of the literature that is available relating to the present research study. The literature search strategy was well defined to include the keywords, terminology, and inclusion and exclusion criteria, as well as the process of review. This was necessary in order to show that the information included has been systematically evaluated for the purpose of providing the most extensive data available. Keywords and terminology were included in order to allow for the replication of this search strategy to further provide validity to the results. This was followed by a review of the literature selected to define and justify the use of the Andersen's behavioral model of health services utilization ((Li et al., 2015).

After providing justification for the framework, the literature review then followed the guidelines to provide a review of the literature associated with the factors influencing the utilization of health care services. This provided the reader with the most recent findings in the field of research associated with the utilization and compliance of health care treatments. Becoming more narrowly directed towards the present study, the

literature review then transitioned into literature available regarding the implementation of DOTS This led to a general description of the directly observed therapy protocol that will become more specifically related to the study as the researcher presents data regarding the studies that relate to research variables (independent variables: age, gender, HIV status, category TB, and dependent variable: treatment completion). This was followed by a review of previous studies that have utilized similar tactics to collect data in health care research.

In closing, I have supported this literature review by a systematic process of review to alleviate any potential for bias. I have provided evidence both in support and refuting the proposed hypothesis and research questions. It was not my intention of the literature review to answer the research questions. However, it was my intention to provide a solid understanding of the researches that had been conducted and to guide the present study towards adding to the available knowledge as opposed to repeating previous studies. This will add credibility to the present research through the guidance, as well as help in the process of implementing appropriate adaptations to the primary delivery methods of medication to the patients who have tuberculosis in Sierra Leone and to expand these programs to other regions as it is seen appropriate.

Moving forward from the literature review portion of the present research, I focused on the research methodology in Chapter 3 based on the retrospective quantitative discussion that has been supported by the currently available literature. The chapter will include sections that will describe the study design and set out eligibility criteria for sampling. There will also be sections on the study setting, sampling procedure, as well as,

sample size determination. The chapter will also include sections on data collection and management, statistical analysis, review of the research questions and hypothesis, and ethical considerations to protect participants' privacy and rights.

Chapter 3: Methodology

Introduction

The main purpose of this study was to investigate the effect of patient characteristics on the completion of TB treatment regimen among patients enrolled in the DOTS program in Sierra Leone. Several factors influence successful TB treatment, including the availability of drugs, access to health care services, and several patient factors (Elkomy et al. (2013). The focus of this study was to investigate the patient factors that may hinder TB treatment completion irrespective of the availability of drugs as accorded by the DOTS program. In the study, I used a retrospective, longitudinal quantitative design by analyzing secondary data gathered on TB patients undergoing treatment at four regional DOTS centers in Sierra Leone.

I recruited the study participants from patients who had enrolled in the DOTS program between January 2013 and December 2015. This chapter will be organized into three main subheadings: research design, methodology, and threats to validity. In the section on research design, I will identify the study design and describe the variables that were investigated. In the section on methodology, I will elaborate on the target population, state the sample frame, and explain how I drew the samples from the population and determined the sample size for the study. The section will also include an explanation of how I accessed the data and what permissions I sought or was required to access the data. In the final section, I will address the threats to validity and ethical considerations in data access and handling.

Research Design and Rationale

The independent variables of interest that I investigated in this study were patient's age, gender, HIV status, and TB-case category. The effect of each variable was tested on the dependent variable, treatment completion, among patients enrolled in the DOTS program in Sierra Leone. However, the tested variable was controlled for any effect of education, geographic location of the DOTS center, and marital status on treatment completion.

I used a retrospective, longitudinal quantitative design in this study to analyze data collected on TB patients between 2013 and 2015. In was evident from the literature review that a majority of the researchers used a retrospective, longitudinal design to assess the effect of DOTS programs on treatment outcomes (Demeke et al. 2013; Endris et al., 2014; Gadoev et al., 2014; Sunday et al., 2014; Syed, 2014) and that using secondary data reduces time constraints and maximize sample size (Getahun et al., 2013; Hamusse et al. 2014;). A longitudinal design involves conducting several observations of the individual characteristics relative to interacting factors over a long period of time (Aschengrau & Seage III, 2014). This design enables researchers to observe changes in the characteristics of the subjects relative to an external factor or treatment. A retrospective, longitudinal design was appropriate for this study because the effect of TB treatment outcome can only be realized over a long period of time. In the case of TB, it takes at least 6 months before a conclusion can be reached about the efficacy of the treatment (Munro et al., 2007). Since a longitudinal design entails examining data at

different points in time, there is the possibility to establish temporal effect to the outcome.

One of the disadvantages of longitudinal design is the time required for the repeated observations to be completed. In order to address this shortcoming, I used secondary data that were collected during the period between 2013 and 2015. Even though researchers have no control over the parameters that are included in the data, as well as the method of data collection and handling, using secondary data can save a lot of time and resources (Kelder, 2005). Secondary data from population-based national surveys provide a large pool of sample size that can be viewed as representative of the population. The use of secondary data also requires less ethical scrutiny as it does not expose study subjects to more harm due to treatment exposure (Kelder, 2005).

Based on the literature search and the above rationale, I used a retrospective, longitudinal quantitative design since the advantages of using the design outweigh its shortcomings. I analyzed secondary data from four DOTS centers in Sierra Leone that were collected, de-identified, and archived for reference purposes. I used multiple logistic regressions to determine if there was any association between my independent variables of age, gender, HIV status, and TB-case category and my dependent variable of treatment completion, while controlling for the effect of education, marital status, and geographic location.

Methodology

Target Population

I undertook this study in Sierra Leone, West Africa (see Figure 1 below). According to the 2015 national population census report (provisional), the population of Sierra Leone stands at 7,075,641 (Statistics Sierra Leone, 2016). Because of time and logistical constraints, this study was carried out in four main population centers representing each of the four political divisions of the country: Freetown in the Western Area; Makeni, in the Northern Province; Bo, in the Southern Province; and Kenema, in the Eastern Province. The population of Freetown is recorded as 1,050,301, which makes up about one-seventh of the country's total population.

Following the integration of the National Leprosy Control and TB control programs in 1990, the National Leprosy and Tuberculosis Control Program (NLTCP) started implementing the WHO-recommended DOTS program (Africa Health Observatory, 2014). The aim of the NLTCP was to reduce both leprosy and TB burden by increasing access to case diagnosis, disease treatment, and management Africa Health Observatory, 2014). As a result, the number of DOTS centers was increased from 116 to 148 in 2009 and 2010 respectively (Africa Health Observatory, 2014).

The main chest clinic located at the central Freetown Connaught Hospital is the major DOTS center in the country, and it accommodates the majority of the TB patients in the country . It was one of the four study sites for this research.

Figure 1. Map of Sierra Leone showing the four geographic areas for the study. Retrieved from https://www.google.com/search?q=map+of+sierra+leone+showing+provinces

The city of Makeni has a population of 126,059 people and is the hub of the Northern Province (Statistics Sierra Leone, 2016). The Stocco Leprosy/TB Hospital is the main DOTS center in Makeni that was included as a site for data collection for this study. The other DOTS center that was considered for data collection is situated at the Bo Government Hospital. The city of Bo is the largest population center in the Southern Province with a population of 173,905(Statistics Sierra Leone, 2016). The final study site was located at Kenema city site (Kenema Government Hospital), in eastern Sierra Leone.

Sampling and Sampling Procedure

The design of this study required the use of archived secondary data containing information on all the patients who attended the DOTS program at the four study sites. The NLTCP database also provided the general countrywide TB profile. . The patient records contained information on patients' demographics, TB treatment administered, HIV-status, HIV medication, TB-case category, daily attendance at the DOTS center, and treatment outcome.

Sample frame. The prevalence of the number of TB cases in Sierra Leone is estimated as 574 per 100,000 population (Africa Health Observatory, 2014). Based on this estimate, the total number of people with TB can be projected as 40,614 with the current population of 7 million. As a consequence, the proportion of the TB population in the four study sites was inferred from this number. Based on the populations of the cities mentioned in the previous section, I projected the prevalence of TB in Freetown as 6,028; Makeni as 724; Bo as 998; and Kenema as 1,150. The combined prevalence of TB in the four cities accounted for 22% of the total TB prevalence in the country. Therefore, the data were a very good representation of the study population.

In addition, I selected samples from the data based on the inclusion/eligibility criteria outlined herein. Participants in the study were selected only from the four study sites of Freetown, Makeni, Bo, and Kenema. Furthermore, only patient records of those who attended these centers between January of 2013 and December of 2015 were considered eligible for the study. Data from all other DOTS centers outside of these locations and timeframe were not included in the study.

Power analysis/sample size calculation. I used OpenEpi version 3.01 (Dean, Sullivan, & Soe, 2014) to determine the sample size of the population. Since each independent variable affects the dependent variable differently, I used the cross-sectional and cohort design model OpenEpi software to calculate my sample size. The model was suitable for calculating sample size for cohort studies such as the retrospective cohort study I conducted.

In determining the sample size, I made several assumptions about the study population. The assumptions were made about the *OR* of the dependent variable with respect to each independent variable, the ratio of unexposed to the exposed, and the percent of unexposed with the outcome. I searched the extant literature to provide information on the contribution of each primary covariate to the odds ratio of the dependent variable. I could have determined the sample size for each independent variable based on its contribution on the *OR* of the dependent variable. From the results, I would have chosen an independent variable that had contributed the smallest *OR*, and hence, the largest sample size for my study. To circumvent repetition, I decided to search the literature and choose the smallest *OR* contributed by one of my independent variable on the outcome variable and determined my sample size. Based on the literature, I chose the minimum *OR* that would yield the maximum sample size for the study. The covariates of gender, HIV status, geographic location, and TB-case category provided useful information to guide in the selection of *OR* for the determination of the sample size.

Gender of the patient is well documented as a risk factor that contributes to the successful completion of TB treatment for males. Gadoeve et al. (2015) concluded that gender is an important factor that contributed to unfavorable treatment outcome (treatment not completed). Their results indicated that the odds of loss to follow-up (not completing treatment) are 1.5 times higher among males compared to females and that there is 1.8 times greater odds of treatment completion among females compared to males. A similar *OR* was arrived at by Yen et al. (2015), who recorded 1.65 odds of treatment completion among females compared with males.

The built-in environment is well documented as a major determinant of health, and the location where TB treatment takes place has been cited as a major factor for treatment completion (Sunday et al., 2014). Several authors have shown a significant association between the place of TB treatment and successful treatment outcome (Gadoev et al., 2015; Getahun et al., 2013; Sunday et al., 2014; Syed, 2014). The observed association in these studies ranged from 1.5 to 4.77.

Another important variable that contributes to treatment is TB-case category. Sunday et al. (2014) observed 5.14 odds of treatment completion among new TB patients who enrolled in the program for the first time compared to those that are non-new patients such as retreatment cases, defaulted patients, and failed patients. Gadoev et al. (2015) and Yen et al. (2013) recorded *OR*s of 1.67 and 2.3 for unfavorable treatment outcome among non-new TB cases in their studies.

Table 2

Sample Size Calculation

Sample size for cohort studies	
Two-sided significance level(1-alpha):	95
Power(1-beta, % chance of detecting):	80
Ratio of sample size: (Unexposed/Exposed):	7
Percent of unexposed with outcome:	80
Percent of exposed with outcome:	89
OR:	2
Risk/prevalence ratio:	1.1
Risk/prevalence difference:	8.9
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Sample Size – Exposed	170
Sample Size - Non-exposed	1,188
Total sample size:	1,358

Based on the above literature review, the *OR* used to calculate my sample size ranged from 1.5 to 5.14. I, therefore, decided to use the median *OR* of 2; which fell between 1.8 and 2.3, to determine my sample size. The *OR* was used to calculate the minimum sample size required to generate sufficient power for this study. Since my hypothesis is a two-tailed test, I used the 95% *CI* and an 80% power to determine my

sample size. The result of the OpenEpi is summarized in Table 2. The output shows that I needed a total minimum sample size of 1,358 samples.

Sampling procedure. I used a systematic probability sampling technique to select my sample (1,358) from the population. In systematic sampling, the researcher chooses the N^{th} unit of the population after choosing the first sample randomly from the sampling population (Patton, 2002). Probability sampling increases representativeness. This is because each unit has an equal and independent chance of being included in the sample (Patton, 2002).

The sample interval (N^{th} sample) for each study site is determined based on the sample size required and the total number of TB cases. Based on the proportion of the number of TB cases in each city and sample size analysis, the required sample sizes for Makeni, Bo, Kenema, and Freetown are 200, 200, 200, and 800 respectively (see section on power analysis above). In selecting a representative sample for Makeni, the sample interval is first determined, which is four (724/200). I randomly selected the first sample from the first four records. From that point, I selected every fourth record from the patient's hospital register until the total of 200 samples was selected. The procedure was repeated for BO, Kenema, and Freetown. However, I overdrew each sample slightly to make accommodation for any missing data. The total sample drawn was therefore 1,794 cases.

Data Collection and Management

I used secondary data to conduct my research. The process involved reviewing patient data collected between 2013 and 2015 at the TB treatment centers described in the

aforementioned sections. Records on TB treatment are stored on patient hospital cards, as well as the hospital registers. To gain access to the data, I obtained permission from the Ministry of Health and Sanitation to undertake the study. I made preliminary contacts with the ministry and presented my premise to them. I received written assurance that I will be permitted to undertake the study and collect the necessary data whenever I deem it necessary. After my proposal defense and Institutional Review Board (IRB) approved my research, I formally request permission to conduct the research. The MOHS then granted me the formal permission to undertake the research (see Appendix A).

Most hospitals still maintain hard copy hospital records which have to be painstaking combed to extract the required information. The central National Leprosy and Tuberculosis Program maintain some data in Word or Excel format that contains summary information from all treatment centers. However, they did not contain individual patient variables which are the subject of this investigation. I had to extract the information manually from the hospital registers to record them into excel.

Instrumentation and Operationalization of Concepts

The instrument for the data collection was individual patient's hospital records and hospital registers from the period 2013 through 2015. Each treatment center maintains both patient records and hospital registers that contain information on all the patients. The Monitoring and Evaluation (M & E) Unit of each center collates information on the DOTS program and send it to the NLTCP in Freetown. The M & E personnel in each center gives a unique code to each patient and transfers all patient information from the patient's hospital record into the hospital registry without any

patient identifiers. The code book is then kept by a senior M & E officer separately from the hospital register. The M & E officers come to the treatment area periodically (weekly or biweekly) to update their information and their offices are located in different sections of the hospital from the treatment area. All data for this study was, therefore, collected from the de-identified information recorded in the hospital registers from each center. This researcher, however, randomly checked few entries in the registry against patients' hospital records to ascertain accuracy in data entry. This was done at a minimal level to prevent compromising patient identity.

The covariates that were tested in this study were age, gender, HIV status, TB-case category, marital status, education, and geographic location. The outcome variable was treatment completion. The variables will be measured based on the following criteria.

Primary dependent variable. Treatment completion is measured as the number of days of treatment or number of doses completed. For a person to be described as having completed treatment, they must have continued their treatment for 168 days (6 months with 28 days in each month) or have taken 168 doses of their medication. Since the outcome variable is measured in days on treatment, for the purpose of this study, the outcome variable was dichotomized into < 168days/doses for those who did not complete treatment and ≥168 days/doses for treatment completion. The variable was then coded as 1 = Yes (treatment completed) and 0 = No (treatment not completed).

Independent variables.

Age. Age is recorded as the number of years from birth till the day treatment started. The variable age will be divided into four useful categories. The four categories were recorded thus: 0 = 0 to 20 years, 1 = 21 to 40 years, 2 = 41 to 60 years, and 3 = ≥ 61 years.

Gender. Gender were recorded as a dichotomous variable: 1 = male and 0 = female.

TB-case category. All cases that are registering for TB treatment for the first time and have not been on any previous anti-TB medication were referred to as new cases. All other cases that are taking treatment for the second time including those that have defaulted, retreatment cases, and cases that have failed treatment are described as non-new. Therefore, the independent variable TB-case category is dichotomized into the following: 1= new cases and 0 = non-new cases.

HIV-status. HIV status was recorded as a dichotomous variable in this study. It was worth noting that it is the policy of NLTCP that all TB patients be tested for HIV status. Therefore, all TB cases have a known HIV status. All TB cases that tested positive for HIV are coded as 1 = HIV-positive and those that tested negative are coded as 0 = HIV-negative.

Covariates.

Education. Education is measured as the level of attempted or attained at the time of registering for treatment. The variable is recorded as a categorical variable into four

categories: none = 0, some primary/primary education = 1, secondary education = 2 and postsecondary education = 3.

Marital status. Marital status is described as either being married or not married at the time of registration. The variable was recorded as a dichotomous variable: married = 1 and not married = 0.

Geographic location. Data for this study were collected from four hospitals in Freetown, Makeni, Bo, and Kenema. The four hospitals were divided into two geographic categories. Freetown was described as urban and Makeni, Bo, and Kenema will be described as rural. Therefore, the covariate geographic location was dichotomized into rural = 0, and urban = 1.

Data Analysis

My main source of data was from the hospital registers. The information from the hospital registers was supplemented by data from NLTBCP and patients' hospital records. I randomly cross checked some of the data entries in the hospital registers with patient hospitals cards to ascertain that correct entry were done. The data were scanned through and cleaned for missing or incomplete information.

Research questions. The data were used to provide answers to the following research questions.

RQ1: Is there an association between age and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$1: There is no association between age and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_1$1: There is association between age and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

RQ2: To what extent does gender predict the likelihood of treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_0$2: There is no difference in the odds of TB treatment completion between men and women among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_1$2: The odds of treatment completion are different for men and women among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

RQ3: Is there an association between TB-case category and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$3: There is no association between TB treatment completion and TB category among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_1$3: There is an association between TB treatment completion and TB category among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

RQ4: To what extent does HIV status predicts the odds of TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$4: There is no difference in the odds of treatment completion between HIV-positive patients and HIV- negative patients among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_1$4: The odds of treatment completion are different for HIV-positive patients and HIV- patients among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

Analysis plan. Both descriptive and inferential statistics were performed using SPSS version 21, to describe the data set and examined whether there existed any relationship or association between the independent variables of age, gender, HIV status, and TB-case category and the dependent variable of treatment completion. Since the outcome variable and the independent variables were categorical, both bivariate logistic regression and multiple logistic regressions were used to analyze the data (Forthofer, Lee, & Hernandez, 2007). After the assessment of all independent variables in a bivariate analysis, all independent variables that show a significant contribution to the outcome variable were simultaneously modeled into the multiple logistic regressions. The model

then tested the strength of each variable as a predictor of the outcome variable. By identifying the predictor variables that have the most effect on treatment completion, the care provider will be equipped to focus more attention on those individuals who are likely not to complete their treatments.

Threats to Validity

The main problem for the researcher is to show that the outcome variable is not influenced by outside forces other than those the researcher set out to investigate which creates a threat to validity It is imperative that the researcher identifies such threats and take steps to mitigate their effect. In general, there are two types of threats that may affect quantitative research: intrinsic/internal and an extrinsic/external.

Threats to Internal Validity

Threats to internal validity are problems encountered in research that can be controlled by the researcher if rigorous experimental or research procedures are followed (Frankfort-Nachmias & Nachmias, 2008).. They arise from flawed research procedures, and sometimes from the very experiences of study participants. They tend to negatively influence the researcher's ability to draw objective conclusions from the data being collected (Creswell, 2009). They erode our confidence to categorically state the existence of a relationship between our outcome variable and the predictor variables.

The aim of this study was to examine the effect of patient characteristics on treatment completion among TB patients enrolled in the DOTS program in Sierra Leone. Data were collected from four regional DOTS centers. The selection of these centers was crucial, as it may pose a threat to the validity of the study. The participants in these

centers may have different characteristics from the general TB population attending other centers, thereby possibly affecting treatment outcomes. Furthermore, the selection of samples within the treatment population in each center might also introduce selection bias because the entire population will not be used for the study.

Selection bias was addressed in this study in multiple ways. First of all, the TB population data estimates show that these four centers account for 22% of the entire TB patient population in the country. That indicates that the selection of these centers gave a fair representation of the patient characteristics in the country. Furthermore, participants in the study were randomly selected from the available data set so that each patient in the population had an equal probability of being included in the data thereby eliminating any potential selection bias.

Experimental mortality another possible threat to validity that may be introduced in this study is. Because TB is a chronic disease that requires longer duration for a cure, there exists a threat to loss to follow-up. This is particularly important if there is a differential drop-out among one group relative another. Since I am looking at secondary data, differential mortality can also be introduced into the system due to missing data. However, loss to follow-up had minimal effect in this study since I am looking at secondary data that had been collected and we are not following the groups into the future. Furthermore, since the data set is large, any differential dropout may be countered by the sheer volume of the data. In addition, the existence of missing data can be random and will not preferentially favor any group over the other.

Threats to External Validity

As mentioned earlier, selection of the study locations is a possible source of bias, and this may likely introduce a threat to external validity. Since the participants were selected from only four DOTS centers, there is the possibility of erroneously extrapolating the conclusions of the study outcome to the general TB population in the country. The selection of the four DOTS centers was made with the intention to include each geographic region in sample to so to increase representativeness. Even though these centers represent one-fifth of the entire TB population, the sample might not be sufficient enough to make generalization on the population. Because of the potential of this threat, the outcome of this study should be applied with caution to the general TB population.

Ethical Considerations

In conducting research, the researcher has the fundamental responsibility not to cause any harm or distress to the study participants (Creswell, 2009). This is achieved by obtaining consent agreement from patients to participate in the research. The consent agreement should explain in clear terms the right of participants to withdraw from the research at any point they feel unconformable. The researcher should maintain the dignity, and respect the privacy of subjects at all times (Resnik, 2015). That being said, I upheld the highest virtue of academic integrity and respect for individual privacy at all levels in data collection, analysis, and dissemination of the information.

The research proposal was submitted to the Walden Institutional Review Board (IRB) to check for compliance with all ethical standards pertaining to study participants. No data were collected on subjects until the IRB approved that the minimum standard

was met to collect data for the study. The IRB approval number for this research is 11-04-16-0376161. Furthermore, the study proposal was also submitted to the Ministry of Health and Sanitation of Sierra Leone to request permission to undertake the study. The type of variables and information needed for the study were clearly explained to the Ministry officials. Data collection was only initiated after approval from both the Walden IRB and the Ministry of Health and Sanitation for the study to commence.

The research was based on secondary data that were collected on patients undergoing TB treatment in previous years. The data had been stripped of patient identifiers before storage. Therefore, I did come into direct contact with any subject during the course of the research. There were few instances where I attempted to access patient's hospital records with identifiers to verify data entry. However, this was a minute fraction of the entire dataset and did not pose any risk be it physical, psychological, or social to the safety of study subjects. In addition, I did not have any access and did not make any deliberate effort to contact any of the patients involved.

Summary

In Chapter 3, I described the methodology employed in conducting this research. I used a retrospective longitudinal quantitative design in this study with secondary data from hospital registers. The targeted population was TB patients who underwent TB treatment at four DOTS centers in Sierra Leone. In the chapter, I described how the sample size was determined and how it was drawn from the target population. All variables in the study were defined and their levels of measurement well defined. The RQs addressed in the study were restated, and the analytical methods to answer the

research questions were advanced. The various threats to validity were elucidated, as well as and the how their effect on the outcome variable can be mitigated were outlined. The steps taken to maintain patient confidentiality and maintain ethical research standards were discussed. I will discuss the analysis of data and results of the findings in the following chapter.

Chapter 4: Results

Introduction

The primary purpose of this research was to investigate the relationship between patient characteristics and treatment completion among TB patients under the DOTS program in Sierra Leone. In this study, I selected four representative DOTS centers from each of the four administrative regions of the country (Northern, Southern, Eastern Provinces and the Western area). The specific objectives of the study were to investigate how age, gender, TB-case category, and HIV status would predict the likelihood of treatment completion, while controlling for marital status, education, and geographic location as an indicator of access to health service.

This chapter will contain my analysis of data collected from four regional DOTS centers in Sierra Leone. In the chapter, I will provide the general descriptive statistics of the study participants, bivariate results on the contribution of individual covariates on the outcome variable, and the results of a multiple logistic regression analysis that tested the extent of the relationship between each covariate and the dependent variable while holding other variables constant. The chapter will also contain results on the trend of treatment completion from 2013 to 2015 in general and stratified by urban/rural location. I tested the significance of the observed trend using a stratified logistic regression.

Data Collection and Management

I collected data for this retrospective study from four regional DOTS centers in Sierra Leone after gaining Walden IRB approval to conduct the study. The sample included patients who had received treatment from those centers between 2013 through

2015. Based on my sample size calculation, as outlined in Chapter 3, the study required a minimum of 1,358 participants, with 800 from Freetown Chest Clinic, 200 each from Bo Government Hospital, Kenema Government Hospital, and Makeni Stocco Leprosy/TB hospital respectively. The distribution of the sample was based on the proportional prevalence of TB in the four administrative regions.

During data collection, I randomly selected a total of 1,794 cases from the database as outlined in Chapter 3. Of these, 77 cases (4%) were recorded as transferred, 78 died (4%) during treatment, and six had missing variables. The final sample size that was included in the analysis was 1,633 cases. Therefore, the sample size in the final analysis was adequate, and even above the minimum sample determined in the power analysis in Chapter 3.

Results

Summary Descriptive Statistics of Patient Characteristics

Table 3 shows the summary descriptive statistics of the characteristics of the patients that I sampled in the study. The results indicated that among the 1,633 cases, 16.2 % fell within the age group 0–20 years, 54.9 % within 21–40 years, 22.0 % within 41–60 age group, and 6.3 % were greater than 61 years old. The mean age of the study sample was 34.15 years ranging from 1 to 95 years and a *SD* of 15.50 years. More than 60 % of study participants were males, and 32.7% were females. The majority of cases were HIV-negative 1,275 (78.1 %), 1,452 (88.9 %) were new cases of TB, and 983 (60.2 %) were not married.

Table 3

Descriptive Statistics of Patient Characteristics

Patient characteristics	Frequency	%
Age category		
0–20 yrs	264	16.2
21–40 yrs	897	54.9
41–60 yrs	359	22.0
> 61 yrs	103	6.3
Missing	10	.6
Total	1633	100.0
Gender		
Female	612	37.5
Male	1021	62.5
Total	1633	100.0
HIV/TB status		
Negative	1275	78.1
Positive	317	19.4
Missing	41	2.5
Total	1633	100.0
TB-case category		
Non-new	176	10.8
New	1452	88.9
Missing	5	0.3
Total	1633	100.0
Marital status		
Not married	983	60.2
Married	631	38.6
Missing	19	1.2
Total	1633	100.0

(table continues)

Patient characteristics	Frequency	%
Educational level		
None	467	28.6
Some primary/primary education	403	24.7
Secondary education	494	30.3
Postsecondary education	237	14.5
Missing	32	2.0
Total	1633	100.0
Location		
Bo	245	15.0
Freetown	907	55.5
Kenema	246	15.1
Makeni	235	14.4
Total	1633	100.0
Urban/rural		
Rural	726	44.5
Urban	907	55.5
Total	1633	100.0
Year		
2013	554	33.9
2014	561	34.4
2015	518	31.7
Total	1633	100.0

The proportion of those participants with no education or some form of primary education made up more than half of the sample, with 28.6 % with no education and 24.7 % with some/primary education. Those with secondary education made up 30.3 %, and postsecondary education was 14.5 %. Fifty-five percent of the sample was selected from Freetown and about 15 % each from the other three regions respectively. The percentage of the total sample drawn was evenly distributed across the 3 years: 33.9%, 34.4 %, and 31.7 % for 2013, 2014, and 2015 respectively.

Results of Bivariate Analysis of Patient Characteristics on Treatment Completion

I conducted a bivariate analysis to test the effect of each patient characteristic on treatment completion. These results are presented in Table 4. The Chi-square test measured the significance of the contribution. The results indicated that the age of the patient ($\chi^2 = 11.939$, $p < 0.008$); gender ($\chi^2 = 9.117$, $p < 0.003$); HIV/TB status ($\chi^2 = 13.565$, $p < 0.0001$); educational level status ($\chi^2 = 140.068$, $p < 0.0001$); the location of the treatment patient ($\chi^2 = 28.975$, $p < 0.0001$); and the year of the treatment status ($\chi^2 = 42.129$, $p < 0.0001$) significantly contributed to treatment completion as indicated by their respective p values. However, TB-case category ($\chi^2 = 1.410$, $p > 0.235$) and marital status ($\chi^2 = 0.390$, $p < 0.0001$) did not significantly influence the odds of treatment completion among study participants.

Table 4

Bivariate Analysis of Patient Characteristics for Treatment Completed (Yes or No)

Variables	Completed Treatment (No)	%	Completed Treatment (Yes)	%	Total	Chi-square
Age group						
0–20 yrs	108	40.9	156	59.1	264	χ^2 (11.939)
21–40 yrs	281	31.3	616	68.7	897	*p* (0.008)
41–60 yrs	126	35.1	233	64.9	359	
≥ 61 yrs	44	42.7	59	57.3	103	
Gender						
Female	241	39.4	371	60.6	612	χ^2 (9.117)
Male	327	32.0	694	68.0	1021	*p* (0.003)
TB-case category						
Non-new	54	30.7	122	69.3	176	χ^2 (1.410)
New	511	35.2	941	64.8	1452	*p* (0.235)
HIV/TB status						
Negative	411	32.2	864	67.8	1275	χ^2 (13.565)
Positive	137	43.2	180	56.8	317	*p* (0.000)
Marital status						
Not married	342	34.8	641	65.2	983	χ^2 (0.390)
Married	210	33.3	421	66.7	631	*p* (0.532)
Educational level						
None	232	49.7	235	50.3	467	χ^2 (140.068)
Some primary/primary education	175	43.4	228	56.6	403	*p* (0.000)
Secondary education	93	18.8	401	81.2	494	
Postsecondary education	46	19.4	191	80.6	237	

……..(table continues)

Variables	Completed Treatment (No)	Percent	Completed Treatment (Yes)	Percent	Total	Chi-square
Location						
Bo	90	36.7	155	63.3	245	χ^2 (28.975)
Freetown	325	35.8	582	64.2	907	*p* (0.000)
Kenema	105	42.7	141	57.3	246	
Makeni	48	20.4	187	79.6	235	
Urban/rural						
Rural	243	33.5	483	66.5	726	χ^2 (0.991)
Urban	325	35.8	582	64.2	907	*p* (0.319)
Year						
2013	247	44.6	307	55.4	554	χ^2 (42.129)
2014	187	33.3	374	66.7	561	*p* (0.000)
2015	134	25.9	384	74.1	518	

Evaluating the Predictive Ability of the General Logistic Regression Model

I examined the ability of the model to predict the outcome variable correctly by comparing a 2 X 2 classification table of the null model without predictors with that of the model with all the predictors. The results are presented in Table 5. The results showed that the logistic regression model correctly classified the outcome variable (treatment completion) for 71.5% of the cases compared to 66.5% in the null model.

I also examined the omnibus test of model coefficient to see whether the addition of predictors to the regression improved the baseline model. A chi-square test was used to check the significance of the improvement of th model over the baseline model. The result showed that the model was explaining more of the variance in the outcome variable

(see Table 5). This was supported by the Nagelkerke pseudo R^2 value which suggests that the model predicts 18.2% of the variation in the outcome variable (see Table 5).

The Hosmer and Lemeshow (H-L) test for goodness of fit compares the observed cases to the predicted cases by the logistic regression (Field, 2014). An H-L goodness of fit greater than 0.05 shows that the model prediction is not statistically different from observed cases(Field, 2014). The results from Table 5, therefore, demonstrate that the model is a good fit for the data with p =0.721 > 0.05. The results of the above evaluation show that the data fits the regression model and the model can classify the outcome variable correctly for the majority of the cases.

Table 5

Table of Predictive Coefficients

Tests	
Chi-square	X^2 = 217.98, df = 15, p < .0001
Nagelkerke R^2	0.182
Overall 2 x 2 Classification	76.1 [66.5]
Hosmer & Lemeshow (H-L)	(X^2 = 5.34, df = 8, p > 0.721).

Testing Assumptions

The results of a logistic regression are reliable only if certain assumptions are not significantly violated (CITE). Therefore, I tested the following assumptions for violation.

Multicollinearity. I assumed that the correlation between two or more independent variables should not be significantly strong. Multicollinearity is suspected to be violated when the coefficients of correlation matrix between two variables are greater than 0.8 (Green & Salkind, 2011). The results from the correlation matrix analysis show

that the highest coefficient of 0.685 was obtained between the age category (1) and age category (2). Therefore, the assumption of multicollinearity was not violated in the study.

Linearity of the logit. Even though logistic regression does not require linear relationship between the independent and dependent variables, it does assume that the independent variables are linearly related to the log odds (Green & Salkind, 2011). If this assumption is violated, the test underestimates the strength of the relationship and easily rejects the alternative hypothesis as the relationship is not significant (Green & Salkind, 2011). The results from Table 5 show that this assumption was not violated since the H-L goodness of fit test indicated that the data fits perfectly well into the model, $X^2 = 5.34$, $df = 8$, $p > 0.721$. This was further supported by the Nagelkerke R^2 which shows that the model accounts for 18.2% of the variance observed in the outcome.

Influential cases. The model assumes that there should not be cases that have a substantial impact on the model (Field, 2014). This might be an indication of data error and might negatively skew the regression result. This assumption is said to be violated when an estimate of Cook's distance is greater than one (Field, 2014).. The results from the Cook's distance statistics show that the highest value for Cook's distance is 0.00014 < 1.00. Therefore, the assumption was not violated, and no one variable had an unduly influence on the model.

Addressing the Research Questions and Hypothesis from the Results

The univariate analysis indicated that age, gender, HIV/TB status, education, location, and year of treatment individually influenced treatment completion without holding other variables constant. In other to answer the research questions while

controlling for confounding variables, multivariate logistic regression analysis was conducted. All covariates were entered simultaneously into the model. The results of the multiple logistic regression are presented in Table 6 and discussed in the following sections.

Research Question 1

RQ1: Is there an association between age and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$1: There is no association between age and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_1$1: There is an association between age and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

The result from the univariate analysis indicated that age had a significant influence on the likelihood of treatment completion without controlling for other covariates. A multiple regression analysis was therefore conducted to investigate the association between age and treatment completion while controlling for other covariates (gender, HIV status, TB-case category, marital status, education, and location). The results from Table 6 shows that the *OR* were not statistically significant for the different age groups (21 – 40 years [$OR = 1.08$, $p = 0685$], 41 – 60 years [$OR = 1.34$, $p = 0.168$], and ≥ 61 [$OR = 1.35$, $p = 0.276$]). Therefore, the null hypothesis of no association

between age and TB treatment completion cannot be rejected in favor of the alternative hypothesis of an association between age and TB treatment completion while adjusting for the other covariates (gender, HIV status, TB-case category, marital status, education, and location).

Even though the bivariate result indicated some association between age and treatment completion, the multiple logistic regression shows that there is no significant association between any of the age groups and treatment completion while adjusting for all the other variables (gender, HIV status, TB-case category, marital status, education, and location).

Research Question 2

RQ2: To what extent does gender predict the likelihood of treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

$H_0$2: There is no difference in the odds of TB treatment completion between men and women among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

Table 6

Multiple Logistic Regression Analysis of Patient Characteristics and Treatment Completion with OR, 95% CI, Wald and P values (N= 1553)

Variable	*%* [a]	*OR*	*95% CI*		*Wald*	*P*
			Lower	*Upper*		
Age category					2.831	0.418
0–20 yrs	15.71	1.00				
21–40 yrs	55.82	1.08	0.76	1.52	0.17	0.685
41–60 yrs	21.96	1.34	0.89	2.02	1.90	0.168
≥ 61 yrs	6.50	1.35	0.79	2.31	1.16	0.276
Gender						
Female	37.15	1.00				
Male	62.85	1.14	0.89	1.44	1.07	0.301
TB-case category						
Non-new	10.95	1.00				
New	89.05	0.80	0.55	1.18	1.26	0.261
HIV/TB status						
Negative	80.10	1.00				
Positive	19.90	0.62	0.46	0.83	10.51	0.001
Marital status						
Not married	60.27	1.00				
Married	39.73	1.21	0.93	1.57	1.97	0.160
Educational level						
None	28.53	1.00				
Some primary/primary education	25.11	1.36	1.01	1.83	3.96	0.047
Secondary education	31.49	4.78	3.43	6.67	84.98	0.000
Postsecondary education	14.87	4.65	3.07	7.05	52.55	0.000

……(table continues).

Variable	*%* [a]	*OR*	*95% CI*		*Wald*	*P*
			Lower	Upper		
Location						
Bo	15.13	1.00				
Freetown	56.34	1.17	0.84	1.62	0.86	0.354
Kenema	14.29	0.88	0.59	1.32	0.38	0.538
Makeni	14.23	2.31	1.47	3.61	13.31	0.000
Rural/urban						
Rural	55.5	1.00				
Urban	45.5	0.86	0.62	1.19		0.354
Year						
2013	33.74	1.00				
2014	34.06	1.48	1.13	1.93	8.10	0.004
2015	32.20	2.41	1.81	3.21	36.35	0.000

[a] Nonmissing percent frequencies of covariates in the logistic regression model.

$H_1 2$: The odds of treatment completion are different for men and women among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

The results from the logistic regression analysis from Table 6 show that gender does not significantly predict the odds of treatment among TB patients while controlling for age, HIV status, TB-case category, marital status, education, and location (*OR* = 1.14, 95% CI [0.89, 1.44], $p = 0.301$). The results show that we will reject the alternative hypothesis of significant difference in the odds of treatment completion between men and women and accept the null hypothesis of no difference in the odds of treatment completion between men and women when adjusting for age, HIV status, TB-case category, marital status, education, and location.

Research Question 3

RQ3: Is there an association between TB-case category and TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$3: There is no association between TB treatment completion and TB category among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location

$H_1$3: There is an association between TB treatment completion and TB category among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location.

Table 6 shows the results of the multiple logistic analyses conducted to test whether there is an association between TB-case category and TB treatment completion when controlling for other covariates (age, gender, HIV status, marital status, education, and location). The *OR* for new cases compared to non-new cases is statistically not significant, *OR* = 0.80, 95% CI [0.55, 1.18 ($p < 0.261$. Therefore, the null hypothesis of no association between the predictor variable TB-case category and TB treatment completion cannot be rejected in favor of the alternative hypothesis of the existence of significant association. Thus suggesting that the variable TB-case category in the model does not predict the outcome variable treatment completion as there is no association between the two variables, after controlling for other covariates (age, gender, HIV status, marital status, education, and location).

Research Question 4

RQ4: To what extent does HIV status predicts the odds of TB treatment completion among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location?

$H_0$4: There is no difference in the odds of treatment completion between HIV-positive patients and HIV-negative patients among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location

$H_1$4: The odds of treatment completion are different for HIV-positive patients and HIV-negative patients among TB patients in Sierra Leone when adjusting for education, marital status, and geographic location

A multiple logistic regression was conducted to examine to what extent does HIV status correctly predicts the odds of treatment completion among TB patients. The results of the analysis are presented in Table 6. It is evident from the results that the odds of treatment completion among HIV-positive TB patients were 0.62 times less likely compared with those that are HIV-negative assuming all other predictor variables are held constant. The association between HIV status and treatment completion was statistically significant, *OR* = 0.62, 95% CI [0.46, 0.83] and the Wald (10.51) associated with the variable was also statistically significant (p <0.001). That means HIV-positive patients were 38% less likely to complete their treatment compared to their counterparts that were HIV-negative. Therefore, the null hypothesis of no difference in odds of treatment completion can be rejected in favor of the alternative hypothesis of the

existence of a a significant difference in the odds of treatment completion between HIV-positive and HIV-negative patients while controlling for age, HIV status, TB-case category, marital status, education, and location.

Covariates

The results of the multiple logistic regression in Table 6 also contain covariates (marital status, education, and location) and year of treatment. The odds of treatment completion among those that were married was not statistically significant compared with those that were not married, *OR* = 1.21, 95% CI (0.93, 1.57), *p* = 0.160. However, the odds ratio of treatment completion is significant with regards to education and location. The odds ratio of treatment completion is significantly higher among those with some primary/primary education (*OR* = 1.36, *p* = 0.047), secondary education (*OR* = 4.78, *p* 0.0001) and postsecondary education (*OR* = 4.65, *p* = 0.0001) compared with those with no education. With regards to geographic location, those living in rural areas were 0.86 times or 14 % less likely to complete their treatment compared to those that live in the urban area. However, the result is not statistically significant, OR = 0.86, 95% CI (0.62, 1.19), *p* = 0.354. When individual DOTS centers were compared with each other, those receiving treatment in Makeni were 2.31 times (131%) more likely to complete their treatment compared with those living in Bo, *OR* = 2.31, 95% CI (1.47, 3.61), *p* = 0.0001. There was no significant difference in treatment completion between those receiving treatment in Kenema and Freetown when compared with Bo.

Yearly Trend in Treatment Completion

Figure 2 shows the overall yearly trend in treatment completion. It is evident that treatment completion improved over the years. There was a decline in the number of those that did not complete their treatment from 48.4%, in 2013 to 25.4% in 2015 while those that completed treatment increased from 51.6% to 74.6% respectively.

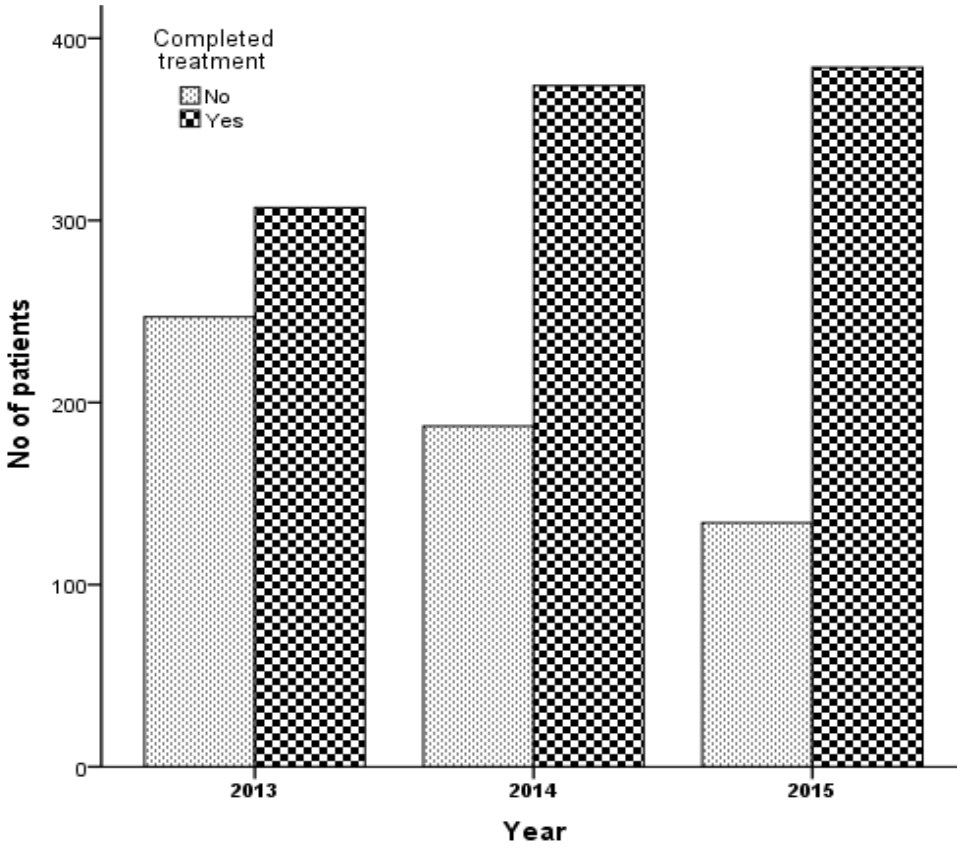

Figure 2: Yearly trend in treatment completion.

The difference in trend between the years was tested to see whether it is significant. The *OR* for TB treatment completion in 2014 and 2015 were significantly higher compared to 2013. The *OR* for 2014 and 2015 were respectively *OR* = 1.48, 95%

CI (1.13, 1.93), $p = 0.004$); and $OR = 2.41$, 95% CI (1.81, 3.21), $p = 0.0001$. The results suggest that the odds of the likelihood of treatment completion increased by 48% in 2014 and 141% in 2015 compared to 2013 respectively.

Stratified Multiple Regression Analysis Based on Location

The results of the general logistic regression showed that HIV status of the patient, his or her educational level, the location of the treatment and the year of the treatment could predict the likelihood of TB treatment completion in the general sample. A stratified multiple regression was therefore conducted to ascertain the predictive ability of the covariates with respect to the location. The sample was dichotomized into urban and rural location and modeled into a multiple regression analysis. The results are presented Tables 7 and 8 and discussed in the following sections.

Multiple Regression Analysis of Patient Characteristics in Rural Areas

Table 7 shows the results of a multiple regression analysis of treatment completion based on rural residency. The total number of cases sampled was 678 with complete data points. The results are similar to the general logistics regression for the entire sample. The results show that HIV status, education, and year of treatment were significant in predicting treatment completion among residents in the rural areas. The odds of the likelihood of treatment completion among HIV - positive patients was 48% less likely compared to those that were HIV – negative, $OR = 0.52$, 95% CI (0.31 - 0.88), $p = 0.014$.

Table 7

Stratified Multiple Logistic Regression Analysis of Treatment Completion (Rural) with Odds ratio (OR), 95% CI, Wald and P values (N= 678)

Variable	*%* [a]	*OR*	*95% CI*		*Wald*	*P*
			Lower	*Upper*		
Age category						
0–20 yrs	18.73	1.00				
21–40 yrs	51.92	0.88	0.52	1.49	0.24	0.624
41–60 yrs	22.12	1.16	0.61	2.19	0.21	0.650
≥ 61 yrs	7.23	2.08	0.94	4.64	3.23	0.072
Gender						
Female	40.27	1.00				
Male	59.73	0.94	0.65	1.35	0.11	0.744
TB-case category						
Non-new	10.62	1.00				
New	89.38	0.66	0.35	1.23	1.72	0.190
HIV/TB Status						
Negative	86.43	1.00				
Positive	13.57	0.52	0.31	0.88	6.05	0.014
Marital status						
Not married	59.73	1.00				
Married	40.27	0.87	0.57	1.34	0.40	0.529
Educational level						
None	32.01	1.00				
Some primary/primary education	21.68	1.27	0.80	2.01	1.06	0.304
Secondary education	0.09	5.19	3.10	8.68	39.36	0.000
Postsecondary education	16.22	8.00	4.07	15.73	36.33	0.000

…….(table continues)……

Variable	*%* [a]	*OR*	*95% CI*		*Wald*	*P*
			Lower	Upper		
Location						
Bo	34.66	1.00				
Kenema	32.74	0.95	0.62	1.44	0.07	0.794
Makeni	32.60	2.58	1.63	4.10	16.18	0.000
Year						
2013	32.01	1.00				
2014	33.48	1.02	0.66	1.55	0.01	0.942
2015	34.51	1.84	1.18	2.87	7.21	0.007

[a] Nonmissing percent frequencies of covariates in the logistic regression model.

Education had significant impact on treatment completion among residents in rural areas. The odds ratios for those with some primary/primary education, secondary education, and post-secondary education are *OR* = 1.27, 5.19, and 8.00 respectively. This shows that the likelihood of treatment completion improved from 1.27 times among those with some primary/primary education to eight times among those with post-secondary education when compared with those with no education.

Table 7 also shows that within the rural centers, patients that received treatment in Makeni had 2.58 times likelihood to complete their treatment compared with those that received treatment in Bo. There was no significant difference between those that received treatment in Kenema compared with those that received treatment in Bo. Overall, treatment completion improved slightly over the years as the likelihood of completing treatment in 2014 was not significant (*OR* = 1.02, 95% CI [0.66, 1.55], *p* = 0.942) but 84% more likely in 2015 (*OR* = 1.84, 95% CI [1.18, 2.87], *p* = 0.007) compared to treatment completion rate in 2013.

Multiple Regression Analysis of Patient Characteristics in Urban Freetown

The results of a multiple logistic analysis of patient characteristics receiving treatment in the urban DOTS center are presented in Table 8. The total number of cases with no missing data in the analysis was 875. The results of the regression analysis indicate that HIV status, marital status, educational level, and year of treatment were significant in predicting treatment completion among TB patients receiving treatment in DOTS center in the urban area (see Table 8). The odds ratio of the likelihood for treatment completion among HIV – positive TB patients was 44% less likely compared to HIV – negative patients., $OR = 0.66$, 95% CI (0.52, 0.94), $p = 0.022$.

It is interesting to note that marital status is a significant predictor of TB treatment completion among urban residents. The odds of the likelihood of treatment completion increased by 52% among those that were married compared to those that were not married, $OR = 1.52$, 95% CI (1.09, 2.13), $p = 0.015$. The results further showed that treatment completion was only significant for secondary and post-education education in urban areas. Even though treatment completion improved with education, having secondary education was the threshold for completing treating in urban area. The OR for the two educational levels compared with no education were $OR = 4.68$, 95% CI (0.95, 2.31), $p = 0.0001$ and $OR = 3.34$, 95% CI (1.94, 5.74), $p = 0.0001$.

Table 8

Stratified Multiple Logistic Regression Analysis of Treatment Completion (Urban) with Odds ratio (OR), 95% CI, Wald and P values (N= 875)

Variable	*%* [a]	*OR*	*95% CI*		*Wald*	*P*
			Lower	*Upper*		
Age category						
0–20 yrs	13.37	1.00				
21–40 yrs	58.86	1.28	0.80	2.06	1.06	0.302
41–60 yrs	21.83	1.64	0.93	2.89	2.95	0.086
≥ 61 yrs	5.94	1.08	0.51	2.32	0.04	0.838
Gender						
Female	34.74	1.00				
Male	65.26	1.30	0.94	1.80	2.46	0.117
TB-case category						
Non-new	11.20	1.00				
New	88.80	0.87	0.53	1.42	0.31	0.580
HIV/TB status						
Negative	75.20	1.00				
Positive	24.80	0.66	0.46	0.94	5.24	0.022
Marital status						
Not married	60.69	1.00				
Married	39.31	1.52	1.09	2.13	5.96	0.015
Educational level						
None	25.83	1.00				
Some primary/primary education	27.77	1.42	0.95	2.13	2.89	0.089
Secondary education	32.57	4.68	2.99	7.33	45.48	0.000
Postsecondary education	13.83	3.34	1.94	5.74	18.93	0.000

……...……..(table continues)

Variable	*%* [a]	*OR*	*95% CI*		*Wald*	*P*
			Lower	Upper		
Year						
2013	35.09	1.00				
2014	34.51	1.87	1.32	2.66	12.30	0.000
2015	30.40	2.93	2.00	4.30	30.10	0.000

[a] Nonmissing percent frequencies of covariates in the logistic regression model

Table 8 also shows that the likelihood of treatment completion improved over the years. The odds ratio of the likelihood of treatment completion improved by 87% in 2014 and 193% in 2015 when compared with 2013 respectively. The age, TB-case category, and the gender of the patient were not significant variables in predicting TB treatment completion in the urban area. It can be concluded that HIV status, marital status, educational level, and year of treatment are significant in improving treatment completion rates among urban patients.

Summary

The analysis and results of a retrospective data collected on patients registered for TB treatment in four DOTS centers between 2013 through 2015 was discussed in the preceding sections. In this I examined four independent variables (age, gender, TB-case category, and HIV status), one categorical variable (treatment completion) and three covariates (marital status, education, and location). Univariate analysis was conducted to examine the predictive ability of each independent variable on the outcome variable. This was followed by multivariate logistic regression analysis to control for the contributory effect of other covariates.

I investigated four RQs with their attendant hypothesis. The aim of RQ 1 was to examine the association between age and treatment completion while controlling for

marital status, education, and location. Based on the results, I rejected the alternative hypothesis of an association between age and treatment completion and accepted the null hypothesis that there was no association between age and treatment completion when controlling for marital status, education, and location.

In R Q 2, I tested the extent to which gender can predict treatment completion among TB patients. There was no significant difference in the likelihood of treatment completion among males when compared with females. Therefore, gender is not a good predictor of treatment completion.

RQ 3 examined the association between TB-case category and treatment completion. No significant difference was observed in the odds of completing treatment among those that were new cases compared with non-new cases.

RQ 4 examined the extent to which HIV status predicts the odds of treatment completion and TB patients. The results of the analysis supported the alternative hypothesis of that there is a difference in the odds of treatment completion between HIV–Positive and HIV–Negative patients.

My results also indicated that the level of education and the year in which treatment was administered predicted the odds of the likelihood of treatment completion. The overall result showed that program performance improved over time as the proportion of those that did not complete their treatment significantly decreased with time.

This chapter is followed by Chapter 5 where I will discuss the results of the investigation. I will also interpret the results as it relates to the literature and general public health practice. I will give some recommendations relevant to improve treatment outcomes, as well as areas of for further research studies.

Chapter 5 Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to identify key patient characteristics that will predict TB treatment completion among TB patients enrolled in the DOTS program in Sierra Leone. Many factors are believed to affect patient's ability to engage fully in the utilization of the DOTS program for the treatment of TB, including patient characteristics, availability of drugs, availability of personnel to directly administer the program tenets, HIV prevalence, stigma, and early diagnosis (Vijay et al., 2010). Therefore, I conducted a retrospective cohort study to investigate how patient characteristics affect treatment completion among TB patients in Sierra Leone. Data were extracted from patient records from four DOTS centers in the country (Bo, Freetown, Makeni, and Kenema). The DOTS centers were chosen to represent the four administrative divisions in the country.

Summary of Key Findings

The results of my analysis of the data showed that a majority of the TB patients (55%) were between the ages of 21 to 40 years with a mean age of 34.18 years, mostly male (63%), not married (60%), were HIV-negative (78%) and presented with new TB cases (89%). With the exception of TB-case category, age, gender, and HIV status were considered significant predictors of TB treatment completion among TB patients in a bivariate analysis. However, a logistic regression analysis of the data failed to establish any significant predictive ability of age, gender and TB-case category on treatment completion but confirmed that HIV status was a significant predictor of TB treatment

completion. The *OR* of the likelihood of treatment completion was significantly lower among HIV-positive patients compared to those that were HIV-negative. The results also showed significant differences in the odds of the likelihood of treatment when the educational level of the patient, treatment location, and year of treatment were taken into account.

Interpretation of the Findings

My specific objective with this study was to investigate whether patients' age, gender, TB-case category, and HIV status affects treatment completion among TB patients while controlling for education, marital status, and location. I hypothesized that there was no significant association between TB treatment completion and age or TB-case category. The results indicated that the null hypothesis could not be rejected, and therefore treatment completion had no significant association with age or TB-case category. I also hypothesized that there was no difference in the *OR* of TB treatment completion between men and women or between HIV-positive patients and HIV-negative patients. The result of the study showed that the odds of the likelihood of TB treatment completion were not statistically different between men and women, but the likelihood of TB treatment completion declined among HIV-positive patients when compared with HIV-negative patients.

Interpretation of the Findings With Relation to the Literature

RQ1. With the first research question, I tested the existence of an association between age and TB treatment completion. The *OR* from the logistic regression analysis was not significant ($p > 0.05$). The odds of the likelihood of treatment completion was

not significant among any of the age groups. The result showed that there was no significant association between TB treatment completion and age while holding all other variables constant. This means that TB treatment completion was not affected by age.

This finding was in agreement with results obtained by Endris et al. (2014). Endris et al. reported that there was significant association between age and unsuccessful treatment outcome. However, the result of their study should be interpreted with caution as the sample size was significantly small (417) to give a stronger statistical power.

The findings of this study with regards to age and treatment outcome are in contradiction with several other studies (e.g., Demeke et al., 2013; Hamusse et al., 2014; Syed, 2014). Demeke et al (2013) observed that the *OR* for treatment success decreased with age. In their study, patients in the age group greater than 15 years old were significantly less likely to have successful treatment outcome compared to those that were less than 15 years old. Similar results were reported by Hamusse et al. (2014), who indicated that age groups 25–49 and ≥ 50 years were significantly associated with unsuccessful treatment outcomes. The findings of both studies can be explained by the fact that as patients age, their immunity declines, and therefore, they are easily prone to be overwhelmed with opportunistic infections such as TB. The differences in the outcome between this study and those of Hamusse et al. can be attributed partially to sample size. Hamusse et al. used a large sample size of 14,221 compared to 1,633 cases in this study. But this does not hold true in the case of Syed (2014) and Demeke et al. who used 609 and 2,303 cases respectively.

RQ2. With the second research question, I examined the extent to which gender can predict treatment completion among TB patients in Sierra Leone. I hypothesized that there was no significant difference in odds of treatment completion between men and women among TB patients in Sierra Leone while holding other covariates constant. The result of this study showed that the odds of treatment completion among men increased by 14 % but was not statistically significant enough to make any difference in odds of treatment completion between men and women. In general, men were more affected by the TB disease than women, accounting for 63 % of all cases.

Even though the results of this study regarding gender are similar to the outcome obtained by Endris et al. (2014), they are different from those arrived at by Gadoev et al. (2015) and Jemal et al. (2015). These researchers opined that being male was associated with negative treatment outcome.

RQ3. In developing RQ3, I set out to answer whether there is an association between TB-case category and TB treatment completion. My null hypothesis of no association between TB-case category and TB treatment completion was upheld based on the results from the multivariate logistic regression. The majority of the TB cases were new patients, but their odds of the likelihood of TB treatment completion were not statistically different from those that were non-new cases. The findings in this study are in contrast with studies undertaken by Gadoev et al. (2015) and Hamusse et al. (2014). In a large retrospective study of 107,380 patients, Gadoev et al. found that patients that were previously treated (non-new cases) were associated with loss-to-follow-up compared with new cases. In a similar study, Hamusse et al. also concluded that retreatment cases were

more associated with unsuccessful treatment than new cases.

RQ4. My aim with RQ4 was to investigate to what extent HIV status predicts the odds of treatment completion among TB patients in Sierra Leone. The results of this study showed that the prevalence of HIV among the TB subpopulation is far greater than the general population. There were 19.4% of TB patients that were coinfected with HIV compared to 1.5% in the general population. Among these cases, 43% did not complete their treatment. The results of the multivariate analysis showed that the outcome was statistically significant. The odds of treatment completion among HIV-positive cases was 38% less likely compared to those that were HIV–negative. This result was in conformity with results obtained by Hamusse et al. (2014), Gadoeve et al. (2015), and Jemal et al. (2015). This study had a similar outcome with what Jemal et al. concluded in their study. The result of their study showed that 20% of TB patients were coinfected with HIV and that being HIV-positive negatively affected treatment success rate. In a similar study, conducted by Gadoeve et al. to investigate risk factors associated with unfavorable treatment outcome, the authors concluded that being HIV-positive was associated with death, loss-to-follow-up, and treatment failure. This finding was further supported by the findings of Hamusse et al. who also concluded in their study that TB/HIV coinfection was associated with unsuccessful treatment outcome.

The conclusions from these findings can be put into perspective. The lack of association between age, gender, and TB-case category as opposed to what generally exists in the literature can be partly attributed to sample size. It is probable that the sample size I used in this study was not large enough to capture any significant

differences that would support the alternative hypothesis in favor of null hypothesis. Therefore, it is prudent that future researchers should consider increasing the sample to have a clearer picture of the impact of these variables on treatment completion.

It is no surprise that being HIV-positive negatively affects treatment completion as concluded in this study. It has been widely reported that HIV weakens the immune system, and therefore, provides the right environment for opportunistic infections like TB to thrive (Gordin & Masur, 2012). The HIV epidemic has accelerated the resurgence of TB in societies where latent TB is endemic(Gordin & Masur, 2012). Patients infected with HIV have a 50% chance of reactivating latent TB compared to only a 10% chance among HIV-negative patients (Nyamogoba et al., 2012). It is believed that HIV infection is the greatest risk factor for new TB infection and also has the most significant potential for TB recurrence (Nyamogoba et al., 2012). This does not address the question of why HIV/TB coinfected patients fail to utilize the available sources in the form of DOTS program to complete their treatment though. It can be argued that once TB patients find out that they are HIV-positive, they lose hope and tend to resign altogether in life and refuse to continue treatment. This is particularly true in scenarios where proper counseling is lacking that would educate patients about the benefits of the treatment. Efforts should be accelerated to educate patients that both diseases can be treated or managed and that they still have the chance to live a higher quality and productive life.

Covariates. The results of this study showed that education, location, and year of treatment had a significant impact on treatment completion. Education was shown to be a major predictor of treatment completion, especially in rural areas. Similar conclusions

were arrived at by Syed (2014), who identified rural residency and illiteracy as having a significant association with treatment failure. Sunday et al. (2014) also concluded that the location where patients received their treatment had a significant association with favorable treatment outcome.

The results from this study showed that as the level of education increases, the odds of treatment completion improves by eight-fold in the rural areas compared to those who had no education. The results did not reveal a dramatic increase in odds of treatment completion beyond secondary level in urban centers. It was apparent that acquiring secondary education in an urban environment is the threshold required for enhanced participation in the DOTS program. This can be attributed to the fact that urban residents are inundated with information through various sources such as radio, television, and Internet which might be lacking in rural areas. Therefore, urban residents are better equipped with information about services outside the academic sphere.

The results of this study also demonstrated that overall treatment performance improved over the years. The number of patients that dropped out of the DOTS treatment program almost reduced to half from 44 % in 2013 to 24 % in 2015. The *OR* for treatment completion increased by 1.48-fold in 2014 to 2.41-fold in 2015 compared to 2013. The result was even better in the urban area which improved three- fold in 2015.

It seems that there was an improvement in DOTS program performance in 2015 despite the ebola epidemic in 2014 through 2015, which decimated the health care infrastructure in the country. This could be explained by the fact that the government, in its effort to meet the target set by Millennium Development Goals for TB in 2015, had

already put in place resources and strategies to improve program performance before the ebola outbreak. The MOHS developed treatment guidelines that integrated TB and HIV treatment in a package. They also trained community health workers that were solely responsible for increasing awareness about TB disease and to monitor quality indicators for service delivery. The MOHS also partnered with the World Food Program to provide nutritional support services to highly malnourished HIV and TB patients in vulnerable communities. The overall effect of these efforts was an improvement in DOTS program performance by a reduction in dropout rates among TB patients in 2015.

Interpretation of the Findings in the Context of the Theoretical Framework

The theoretical framework for this study was based on the Andersen's behavioral model of health services utilization. The model posits that health services utilization is influenced by predisposing factors, enabling factors, and need factors (Kim, et al., 2010). In this study, I used mainly the predisposing factors that predict DOTS utilization in the completion of TB treatment. The predisposing factors that were considered in this study were patient's age, gender, marital status, and location of treatment. The predisposing factors considered in this study were not significantly associated with service utilization, which is in direct contrast with what is predicted by Andersen's model. According to several studies using Andersen's model, education (an enabling factor) is perceived to have a direct relationship with service utilization. The results in this study also confirmed that education was significantly associated with treatment completion among TB patients. The need factors addressed in this study were TB-case category and HIV status. Patients who think that their health conditions are poor were significantly more likely to receive

treatment for their condition than those who believe that they are in excellent health. I did not find any significant difference in service utilization among patients who had new TB cases from those that were retreated, defaulted, or failed treatment the first time around. However, HIV-positive TB patients were less likely to complete their treatment than their HIV-negative counterparts.

The model, however, did not address the trend in service utilization as depicted by the rate of treatment completion. It is evident from the result that treatment improved over time significantly. It can be argued that the main RQs did not include trend. However, the results have shown that the observed trend cannot be ignored in the final discussion. In that respect, the traditional epidemiological triad of person, place and time could have provided an inclusive model to interpret the results in its entirety. The person in the epidemiologic triad is the characteristics of the TB patients such as age, gender, marital status, education, TB-case category, and HIV status. One essence of program evaluation is to improve performance over time. Therefore, the time variable in this study is relevant. The place is the DOTS location where treatments were administered. From the result, treatment completion is affected by one patient characteristic (HIV) and that treatment completion is affected by the location which improved over time.

Limitations of the Study

As has been stated earlier, I conducted the study in only four DOTS centers in Sierra Leone that treated patients between the periods 2013 through 2015. It does not include data on the more than 100 DOTS centers across the country. The research is limited to only those centers and the period stated. It is possible that patients attending

other DOTS centers might have different treatment outcomes on patient characteristics. The results in this study may therefore not be a representative of the entire TB patient population in the country. This will pose a threat to eternal valid of the outcome.

The use of secondary data in itself poses limitations as I did not defined or recorded the variables.. There is potential for the introduction of errors in the record which is beyond the control of the researcher. Also, patient records indicate that some patients were transferred out but there was no way to track those patients. Some records also contained missing patient information that made it impossible to include them in the analysis. Because of that the records of patients that were transferred out and those with missing information were eliminated from the final analysis.

Recommendations

Robust program implementation should include program evaluation. Program evaluation helps to highlight efficacies and shortcomings in the implementation process. The MOHSshould engage in evidence-based activities through research to better understand trends in the implementation of the DOTS program. Such events will provide a blueprint for the surveillance of TB transmission in the country. In order to build a better surveillance system, proper attention should be dedicated to data collection, management, and storage. There was no consistent pattern in the way data is collected and stored from one DOTS center to the other. Once patients complete their treatment or drop-out of the program, patient hospital records were haphazardly stored all over the place. Several variables were incomplete in the patient's records. The MOHS should

dedicate resources to training staff in data handling and storage. This will be assistance in future research that is low cost, and enhance surveillance of the TB disease.

This study was undertaken in only four DOTS centers in the country. The reported treatment completion rate of about 66% in this study was far below the government reported treatment success rate of 88%. It is recommended that follow-up research be undertaken that covers the entire country to provide a comprehensive analysis of the DOTS program. Another area of research that is recommended is to look at the impact of socioeconomic status, and access to health care especially with regards to transportation or distance from the DOTS centers. The prevalence of MDR-TB and its impact on treatment outcome should also be considered for further research.

Furthermore, the HIV prevalence rate in this study raises an alarm bell in the fight against the disease. It seems that the government reported prevalence rate far more underestimates the actual scenario in the country. It is therefore recommended that detailed study be instituted to help understand the actual threat level of HIV in the country. The MOHS should assign case managers to patients that have the potential to drop out od the program such as HIV/TB patients in order to improve on program performance. The rural communities should be educated about the availability of the treatment for TB.

Social Change Implications

This study is among a very few evidence-based studies that had been undertaken to assess the implementation of DOTS program in the treatment of TB in Sierra Leone after decades of its implementation. In that regard, it provides valuable literature that is

useful to policymakers, healthcare professionals, and scientists or researchers on the DOTS program in Sierra Leone. It is evident from the study that HIV still remains a significant public health threat in Sierra Leone. It is not only due to the suspected increase in the prevalence of HIV, but also the negative impact it had on TB treatment. Therefore, DOTS program implementers should refocus their attention on this subset of the TB population to help improve on program performance.

It is also noted in this study that education and residency impact treatment completion. Patients in rural communities are more likely not to complete their treatment than residents in urban areas. It seems that education in rural communities is a major factor that increases the likelihood of treatment completion, whereas in urban centers, acquiring a secondary education is the threshold for maximum participation. This might be because residents in the urban area receive information about government programs such as DOTS from different sources outside of formal education whereas residents in the rural areas receive their information mainly through formal education. Unfortunately, the illiteracy rate in the rural communities is far greater than those in the urban communities. The government should, therefore, concentrate resources on information dissemination about various health programs including DOTS in rural communities. These communities do not have the many access to information such as internet, cable television, phone applications, and radio that urban residents enjoy.

Conclusion

The results of this study showed that the majority of those suffering from TB were young uneducated or semieducated, unmarried males under 40 years old. About 19.4% of

TB patients were coinfected with HIV which is far above the national prevalence of 1.5% of the HIV disease. This trend, if not addressed, will pose a major threat to the successful implementation of DOTS program in the treatment of TB as HIV-positive patients were less likely to complete their treatment. The results failed to identify other patient characteristics such age, gender, and TB category as predictors of treatment compliance. However, education seems to play a major role in treatment completion which tends to improve over time.

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Appendix A: Letter of Cooperation

GOVERNMENT OF SIERRA LEONE
MINISTRY OF HEALTH AND SANITATION
OFFICE OF THE CHIEF MEDICAL OFFICER

Thursday, November 10, 2016

The Medical Laboratory Scientist
Department of Pathology & Laboratory Medicine
Washington Hospital Center
Washington DC
USA

Attn: Mohamed Lamin Sesay

Dear Sir,

Letter of Cooperation to Conduct Research on the DOTS Program in Sierra Leone

Your request to obtain permission to conduct research on the ***"Effect of Patient Characteristics on Treatment Outcomes among Tuberculosis Patients in Sierra Leone"*** as described in your proposal has been received. Based on the review of your proposal, I hereby grant you permission to collect data on patient characteristics and the outcome of their treatment as implemented by our DOTS program. It is our understanding that you will access data that had already been collected and achieved by our staff and that you do not need to come into contact with any of the patients.

We will provide you the necessary assistance in terms of personnel you may stand in need to facilitate your data collection. The activities of the staffs are limited to giving you access to our database and storage facilities where needed. It is our expectation that all information accessed will be utilized for the sole purpose of the intended research and should remain confidential.

It is our hope that the results and recommendations of your research will provide useful information that will enhance the implementation of our DOTS program in its effort to reduce the transmission and prevention of tuberculosis in Sierra Leone.

Yours faithfully,

Dr. Brima Kargbo (GOOR)
Chief Medical Officer

MINISTRY OF HEALTH AND SANITATION, *4th Floor Youyi Building,Brookfields, Freetown*
Contact Mobile No: 232-76-960071/33-317902; Email: brimakargbo@hotmail.com/brimakargbo@gmail.com

Appendix B: Data Use Agreement

DATA USE AGREEMENT

This Data Use Agreement ("Agreement"), effective as of 12/15/15 ("Effective Date"), is entered into by and between Mohamed Lamin Sesay ("Data Recipient") and Sierra Leone Ministry of Health and Sanitation ("Data Provider"). The purpose of this Agreement is to provide Data Recipient with access to a Limited Data Set ("LDS") for use in research **in accord with laws and regulations of the governing bodies associated with the Data Provider, Data Recipient, and Data Recipient's educational program.** In the case of a discrepancy among laws, the agreement shall follow whichever law is more strict.

1. Definitions. Due to the study's affiliation with Laureate, a USA-based company, unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the USA "HIPAA Regulations" and/or "FERPA Regulations" codified in the United States Code of Federal Regulations, as amended from time to time.

2. Preparation of the LDS. Data Provider shall prepare and furnish to Data Recipient a LDS in accord with any applicable laws and regulations of the governing bodies associated with the Data Provider, Data Recipient, and Data Recipient's educational program.

3. Data Fields in the LDS. **No direct identifiers such as names may be included in the Limited Data Set (LDS).** In preparing the LDS, Data Provider shall include the **data fields specified as follows**, which are the minimum necessary to accomplish the research: DOTS data records from a representation treatment site in Freetown, Bo, Kenema, and Makeni from 2009 to 2013. The data points should include patient's age, weight, socioeconomic status (education, employment, and income), gender, smoking status, HIV status, TB case category, location of clinic (public or private), days on treatment, completion of treatment, died, cured (smear negative post treatment completion) defaulted, censored, and failed (smear positive post treatment completion).

4. Responsibilities of Data Recipient. Data Recipient agrees to:

    a. Use or disclose the LDS only as permitted by this Agreement or as required by law;

    b. Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;

    c. Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;

    d. Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or

disclosure of the LDS that apply to Data Recipient under this Agreement; and

e. Not use the information in the LDS to identify or contact the individuals who are data subjects.

5. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS **for its Research activities only.**

6. Term and Termination.

a. Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

b. Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

c. Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

d. For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

e. Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

7. Miscellaneous.

a. Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

b. Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

c. No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

d. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

e. Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER

Signed: _____

Print Name: Dr. Brima Kargbo
Print Title: Chief Medical Officer
Ministry of Health and Sanitation

DATA RECIPIENT

Signed: _____ 11/9/16

Print Name: Mohamed L. Sesay
Print Title: Ph.D student
Walden University