KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

MAPPING CASES OF TUBERCULOSIS DISTRIBUTION AND TREATMENT OUTCOMES USING GEOGRAPHICAL INFORMATION SYSTEM - THE CASE OF BIRIM CENTRAL MUNICIPALITY, EASTERN REGION - GHANA

BY

BOAZ AHULU

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DECLARATION

I hereby declare that this submission is the result of my own original thesis work towards the award of MSc in Health Informatics and that to the best of my knowledge, no part of this work has been presented to the Kwame Nkrumah University of Science and Technology or any other institution for the award of any certificate except other previously published materials used in this thesis which have been duly acknowledged.

Boaz Ahulu	…….	…..……..
(PG7202916)	Signature	Date
Certified by:		
Dr.Twum Frimpong	…….	……
Supervisor	Signature	Date
Dr. Michael Asante	……..	……
Head of Department	Signature	Date
Mr K. A. Pabbi	……	……
Supervisor	Signature	Date

ABSTRACT

Analyzing the spatiotemporal distribution of tuberculosis (TB) is a very important way to understand its epidemiology thereby helping to identify geographic regions at higher risk and to enable proper control and resource allocation. This study was undertaken to ascertain the spatiotemporal distribution of TB cases and treatment outcomes in the Birim Central Municipality (BCM) for the period 2012 -2016 and to recommend appropriate preventive measures. In this retrospective study, the locations of the total of 268 TB cases identified from 2012-2016 were geocoded on the BCM digital maps. Spatial visualization using choropleth maps, network analysis, and service area analysis of ArcGIS10.2 was used to identify the geographic concentration of cases and the various treatment outcomes as well as proximity of patient community to health facility. A questionnaire was also used to collect primary data from TB patients diagnosed in year 2017. This data was analyzed using SPSS version 21. Five main communities were identified as hot spots of TB in the municipality with variations in other communities. It was found that other non-spatial factors such as socioeconomic factors and stigmatization highly influence treatment outcome. Reducing stigmatization, regular sensitization of health staff who are not directly involved in tuberculosis care, and using a formerly cured TB patient as a peer educator were some of the best ways identified to help improve positive treatment outcomes in the municipality.

Key words: Tuberculosis distribution, treatment outcomes, spatiotemporal distribution

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DEDICATION

I dedicate this work to my lovely wife, Alice.

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ABBREVIATIONS AND TERMS

BCM – Birim Central Municipality

CCM - Country Coordinating Mechanism

CHPS – Community Based and Health Planning Services

DOTs- Directly Observed Treatment short course

GIS – Geographic Information System

MDR- Multi Drug Resistant Strains

NTP- National Tuberculosis Control Program

WHO- World Health Organization

Choropleth map- A map that provides an easy way to visualize how measurement varies across a geographic area

Spatial – The relative position or area of something

Spatiotemporal – the relative spacelocation of something per a time

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter gives an overview of the entire research work. It describes the background and thesis statement as well as the justification and motivation for the study. The chapter also gives attention to the objectives for the study, research questions and the scope of the study.

1.2 Background of the Study

Tuberculosis (TB), classified as one of the three diseases of special public and global health importance, has received much attention to the extent of establishing a whole unit under the Ghana Health Service structures for its control. This disease which has enormous economic and public health burden, has affected a sizeable number of Ghanaians due to its ability to spread easily with associated increased in mortality rates (Yang *et al,* 2012). In spite of the efforts by the National Tuberculosis control program (NTP) in instituting control measures on the disease in the country, there remain some challenges which need to be addressed (Amo-Adjei, 2013a) as case load keep increasing.

The ever increasing number of yearly new TB cases which may be attributed partly to increase in HIV/AIDS cases (Jurcev-Savicevic et al, 2013) calls for pragmatic measures to deal with any obstacle which will prevent the success of the program.

The WHO estimates of over nine million newly diagnosed cases recorded in year 2006, 8% (0.7 million) of the total cases were persons having

HIV. Deaths from TB are much worrying as 1.5 million were recorded in 2006 (WHO, 2008). The Millennium Development Goals (MDG 6) target 6C focused on reducing TB incidence to the lowest level by 2015 (WHO, 2008). Unfortunately, TB/HIV co-incidence as well as other risk factors (JurcevSavicevic et al, 2013) has contributed to increase in cases especially in Asia and Sub-Saharan Africa (WHO, 2008).

For several decades, the TB control program has made some gains in areas of awareness creation in the form of celebration of world TB days, distribution of fliers, health worker training, procuring drugs and other logistics, strong involvement of the laboratory, and involving communities in TB care. There are however, other issues such as identifying the key communities where these cases are coming from and what factors account for the incidence of cases in such communities (Wei et al, 2016).

Some studies (Amo-Adjei, 2013a; Amo –Adjei, 2013b) have highlighted some challenges in the National TB control program but least can be said about its spatial distribution in various communities in Ghana. The use of geospatial analysis can truly help in developing best methods of controlling tuberculosis (Oloyede-Kosoko & Akingbogun, 2013).

Li *et al* (2014) were of the view that for an effective allocation of scarce resources, it is imperative to have deeper insight into spatial variation factors of

TB so that national programs can achieve better results. If the assertion by Oloyede-Kosode and Akingbogun (2013) and Li *et al* (2014) is applicable in control of tuberculosis in Ghana, why has it not been implored in order to facilitate control strategies?

This study intends to ascertain the hot spots of tuberculosis, the types of treatment outcomes in a given geographic location, and the extent of impact of proximity of health facilities to patients homes and how it contribute to a particular treatment outcome. It will help address some of the challenges in the tuberculosis control program in the Birim Central municipality.

1.3 Statement of Problem

Tuberculosis continues to be one of the top communicable diseases of global health importance in many regions in the world. The Birim Central Municipality of Eastern Region in Ghana has a significant share of this disease burden. Tuberculosis which has been given national attention and classified as one of the diseases of special public health focus as well as one of the three named political diseases, seems to be draining both the human and financial resources of most countries including Ghana.

A survey on tuberculosis conducted in 2013 showed a national prevalence of 290 per 100,000 population as against the World Health Organization‟s (WHO) estimate of 71 per 100,000 (CCM Ghana, n.d). All ages are affected with the disease but with majority seen in males than in females with a ratio 2:1 (CCM

Ghana, n.d). In 2013, out of all the regions in Ghana, Eastern region recorded the highest prevalence of Tuberculosis and HIV co-infection of 33.4% and the least 9.4% recorded in Upper East region (CCM – Ghana, n.d).

For some time now, multi-drug resistance strains (MDRs) have increased considerably thereby thwarting the country‟s effort to fully control the problem (NTP, 2014) which is also a major factor in increase in number of cases. If higher numbers of MDRs are recorded in any country, it gives a clear indication of challenges in the control efforts. Apart from the numerous capacity building sessions for service providers, non-governmental organizations as well as international agencies who are well involved in the control effort, the country has not been able to fully control the disease. If tuberculosis is curable as it is the case, why should we continue to battle with its control?

However, some gains have been chocked in some regions of Ghana but there remains higher prevalence of the disease in the Eastern region. The Birim Central Municipality, which is one of largest municipals in the Eastern region, has not been spared at all with large numbers of the disease burden. This is very clear from table 1.1which presents the five year trend of TB cases in the municipality.

Table 1.1: Trend of Tuberculosis Cases and cohort analysis from 2012 – 2016

in Birim Central Municipality

Year	PTB Positive	PTB Negative	Extra PTB	MDRs	Completed	Cured	Defaulter	Failed Treatment	Transf. Out	Died
2012	41	14	4	0	16	32	3	1	2	2
2013	39	16	2	0	20	33	2	1	0	1
2014	37	5	1	0	4	32	0	1	3	2
2015	42	10	0	0	9	35	3	0	1	5
2016	40	15	2	0	14	51	2	0	1	6
Total	**199**	**60**	**9**	**0**	**63**	**183**	**10**	**3**	**7**	**16**

Source: DHA, Birim Central Municipality

It is obvious from table 1.1 that the disease has had enormous public health impact on the people in the municipality. Apart from Government spending huge sums on patients‟ management, there is additional pressure on the health care infrastructure as well as on service providers. Considering the fact that a sizeable number of clients died from the disease condition is much worrying.

The question which keep lingering is: where are the cases coming from and why such communities? Who is getting the cases in such communities – young, elderly, males or females? Are they able to access health care easily and what have been their treatment outcomes? What might be the bottle necks to the control of the disease in the region? Some studies have documented some challenges facing the National TB Control Program (Amo-Adjei, 2013a) but have not given much attention to geospatial analysis of cases.

Several studies on the geo-spatial analysis on TB has been done in countries such as Madagascar, Japan, Portugal, South Africa, China to ascertain the association between TB and socio-economic standards as well as significant hot spots (Wang et al, 2012). These studies have significantly help improve TB control activities in the respective countries. However, in Ghana and more specifically in the Birim Central Municipality, there is no published research on the spatial and geographical distribution of tuberculosis cases reported.

This study therefore seeks to address issues such as where TB cases are clustered, what common reasons can be assigned to the case clustering in an area, and the impact of health facility location and patients treatment outcomes with respect to their residents.

1.4 Motivation for the Study

It is believed strongly that modeling the prevalence of tuberculosis in the Birim Central Municipality is one of the surest ways to target populations for control of tuberculosis and also to ascertain treatment outcomes in relation to a particular geographic area in the municipality. The study result will benefit other districts in the Eastern region to focus their intervention measures on key populations of the public. Reasons for treatment outcomes for certain areas will be ascertained and necessary interventions implemented.

1.5 Justification for the Study

A principle in epidemiology is to know who is affected with a given disease, when the individual or the people are affected, where the cases are located, and why the condition is happening (Center for Disease Control and Prevention, 2005). It is important that every program on health understand and apply such principle if success should be achieved. The TB control program has undertaken several activities such as community awareness creation, case investigation, case management, and contact tracing but little or no work has been done in analyzing the details of the geographic distribution of cases, treatment outcomes, and hot spots of MDRs.

The Birim Central Municipal Health Directorate has not undertaken such study neither has the Eastern Regional Health Directorate embark upon the geospatial analysis of TB cases in all districts of the region. This study intends to address all these issues and will highly be beneficial to the health directorate to develop strategies in TB control. Until a study of this kind is embarked upon in the municipality, key hot spots and reasons for most of the treatment outcomes will be difficult to analyze and will thereby affect efforts to control the disease. Issues that were not considered or not given much attention in TB care may be identified for redress.

Again, knowing the hot spots of cases of TB will help in directing educational programs and searching for more suspected cases in the various communities.
This will make the work of community health workers relatively easy and also to set positive objectives for TB surveillance. Copies of the study report will be made

available to the Regional Health Directorate of Eastern region and Birim Central Municipal Health Directorate for implementation of recommendations.

1.6. General Objective

The main objective of this study is to model tuberculosis distribution as well as treatment outcomes using geographical information system (GIS) in the Birim Central Municipality. The specific objectives to help in achieving the general objectives are as follow:

1.6.1. Specific Objectives

The specific objectives for the study include:

- To ascertain the spatio-temporal distribution pattern of tuberculosis cases and treatment outcomes in the Birim Central Municipality from 2012 to 2016.
- To find out if proximity of health facilities to patients location have any influence on tuberculosis treatment outcome.
- To find out measures which can help improve the control of tuberculosis in the municipality

1.7 Research Questions

The following are the research questions that guided the study:

1. What is the spatio-temporal distribution pattern of tuberculosis cases and treatment outcomes in the Birim Central Municipality from 2012 to 2016?
2. To what extent does proximity of health facilities to patients‟ location influence tuberculosis treatment outcome?
3. What measures can be put in place to improve the control of tuberculosis in the municipality?

1.8 Hypothesis: Null and Alternate Hypothesis The

following are the hypothesis guiding the study:

Research question 1:

H_0: There are no significant differences in the spatio-temporal distribution pattern of tuberculosis cases and treatment outcomes in the Birim Central Municipality from 2012 to 2016.

H_1: There are significant differences in the spatio-temporal distribution pattern of tuberculosis cases and treatment outcomes in the Birim Central Municipality from 2012 to 2016.

Research question 2:

H_0 : There is no significant relationship between the location of health facility and TB treatment success of tuberculosis cases.

H_1: There is significant positive relationship between the location of health facility and TB treatment success.

Research question 3:

H_0 : There are no new measures to be put in place to improve the control of tuberculosis in the municipality

H_1: There are significantly new measures that can be put in place to improve the control of tuberculosis in the municipality.

1.9 Scope of Study

In view of time available to the researcher, proximity and financial challenges, the study was limited only to the Birim Central Municipality.

1.9.1 Delimitations to the Study

The study focuses solely on spatial distribution of tuberculosis cases, multi drug resistant strains (MDRs) as well as the various outcomes of treatment in the Birim Central Municipality using GIS. Only retrospective cases seen from year 2012 to 2016 in the municipality were enrolled for the study.

1.10 Organisation of the Study

The thesis is organized into five chapters. Chapter one is the introduction and it deals with the background to the study, statement of the problem, research objectives, and research questions, significance of the study and the organization of

the study. Chapter two considers the review of related literature, and presents the theoretical and empirical framework of the study. Chapter three covers the research methodology, which deals with the population and sample size, research design, research instruments, and administration of the instruments. Chapter four presents" results of data collected and discusses the findings of the study and chapter five takes summary of findings, conclusions and recommendations made in the research. Conclusion is drawn and some recommendations made accordingly.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter presents available related information to help in understanding the research problem. Both theoretical and empirical works on TB care and spatial

information are considered. Issues such as general information on TB, the effects of HIV/AIDS on TB occurrence and distribution, risk factors in tuberculosis incidences, and proximity of patients to health care facilities or treatment points are discussed.

2.2 General information on Tuberculosis

Tuberculosis, a disease which normally affects the lungs hence sometimes refer to as Pulmonary Tuberculosis (PTB), can also affect any other parts of the body (Extra-Pulmonary Tuberculosis [EPTB]). The disease is one of the significant airborne diseases in Ghana and it‟s transmitted through inhaling the infectious droplets or droplet nuclei from other infectious persons as they cough or sneeze (NTP, 2012). Persons who are exposed to the causative organism may or may not develop the disease depending on their immune status. However, persons who present clinical features such as persistent cough, hemoptysis, night sweat, weight loss and pallor, body weakness, chest pain, difficulty breathing, and loss of appetite are suspected to be suffering from PTB. If the test results show the presence of Mycobacterium tuberculosis (NTP, 2012), the causative organism, then it becomes a confirmed case which needs immediate attention. The same organism can end up in other parts of the body including the meninges of the brain, bones, abdomen, the eye, spine, skin, urogenital area, larynx, or any other part of the body and this is called extra-pulmonary tuberculosis (NTP, 2012).A person with PTB or EPTB becomes very weak physically and needs adequate treatment else he may die.

2.2.1 Tuberculosis and Human Immunodeficiency Virus (HIV)

HIV infection which leads causes AIDS weakens the host immune system of the affected individual making him susceptible to a range of opportunistic infections. Chief among these opportunistic infections is TB. HIV has in fact, fueled the TB disease burden in Africa and in Ghana especially in Eastern region (CCM Ghana, n.d; De Cock et al, 1992; NTP, 2012). These two diseases collectively destroy the immune system at a very fast rate leading to death if not managed promptly. Whiles persons without HIV stand the lifetime risk of 5-10% developing TB(McBryde & Denholm, 2012), those with HIV have a risk of 50% developing TB with about 5% dying within 5 years and 25% developing the chronic form of the disease (NTP, 2012).

A study in Cape Town, South Africa revealed a higher number of persons with HIV are highly at risk of getting tuberculosis and more especially when HIV progresses (Wood et al, 2000). Corbet (2002) concluded that vulnerability of TB increases with HIV-1 infection.

2.3 Risk factors in Tuberculosis Occurrence

The necessary cause of TB is *Mycobacterium tuberculosis* but other factors are necessary before the disease can break out. In a study of risk factors for pulmonary tuberculosis in Croatia, Jurcev-Savicevicet al (2013) enrolled 300 TB patients as against 300 controls selected randomly from the consulting room register. It was

found that social determinants such as unemployment, low level of education, poor housing, and malnutrition increased the progression of TB infection to disease and subsequently, its spread. Poverty indeed is a major factor in TB incidences.

Li *et al* (2014) in a study of pulmonary tuberculosis and spatial distributions with related socio-economic impacts in China, they concluded that tuberculosis control should also focus on interventions that reduce risky life styles and prevention of non-communicable diseases as well as interventions on poverty. They found that past and current smoking status, passive exposure to tobacco toxic substance is much linked with the risk of developing tuberculosis. Again, an individual‟s poor nutritional level which mostly is evidenced by low body mass index (BMI) is associated with increase in the risk of developing TB. In a related study by Wei *et al* (2016) on analysis of local spatial variations of positively diagnosed tuberculosis cases in Xinjiang, China, they indicated significant spatial relationship between socioeconomic determinants and tuberculosis.

The World Health Organization [WHO] (1997, p12) outlined certain factors which contribute to the global burden of the disease and it include increase in the gap between people who are poor and persons who are sound economically, there is a neglect of some diseases which affects the poor more including tuberculosis. The overwhelming collapse of the health infrastructure in some countries also plays a role in increase number of tuberculosis cases. All these factors as explained by the

WHO are some of the factors which contribute strongly to the spread of the disease in communities.

In Ghana as well as in other parts of the world, fear of stigmatization poses a big challenge for suspected individuals to report early to the nearest health facility for management (Møller et al., 2011). The delay in reporting cases therefore facilitate the spread of the disease. More importantly is the ability for service providers to detect cases which visits the hospital for other health reasons (Kripalani, Jackson, Schnipper, & Coleman, 2007). In buttressing this, Storla et al (2008) examined as many as 58 different studies that addressed why tuberculosis cases are not identified and diagnosed promptly and for subsequent on-time management. Six important causes responsible for the delays included demographic, financial burden, stigmatization against the disease, distance to reach the health facility as rural folks have to travel longer hours, seeking care from quacks, and visiting several health facilities before actual diagnosis. Storla *et al* (2008) also were of the view that adequate understanding by service providers on the clinical features and what to do when cases are suspected, will greatly increase early detection thereby reducing the spread of the disease.

In some communities in Ghana, the person with TB is not allowed to be part of any part of public occasion or gathering, not allowed to marry or be married to anyone in the community, and must adhere to certain principles when in any public area

(Dodor & Kelly, 2009). Persons who are exhibiting the clear features of TB and for fear of being stigmatized will never report to the health facility for management. This in effect will lead to low case detection of TB. Per the 2013 prevalence survey in Ghana, there should be 290 cases of all forms of TB in every 100,000 population and 111 per 100,000 positive smear TB cases (NTP, 2014). However, the NTP is now using district specific targets using cases reported in 2014 as baseline for projection of cases.

In a related study of delay in tuberculosis management in Taiwan, Chern *et al* (2008) accessed retrospective records of 31,937 TB cases from 2002 to 2005 from the national TB registry. The cause of delay was either from health care system delaying diagnoses or treatment or the patient delaying in reporting to the health facility. The mean delay from diagnoses to treatment declined from 6.1 days in 2002 to 3.0 in 2005. Chen *et al* (2008) concluded that delay in treatment of cases increases the risk of spread of TB. Therefore, surveillance on TB is very essential to detect cases early as well as treating them without delay (Chern et al, 2008).

Similarly, Huong *et al* (2007) in their study to establish the relationship between when cases are diagnosed and when clients are managed in Vietnam found a strong association with delayed case detection and health facility type that patients visit when they have cough suggestive of TB. They found that delay in diagnosing patients with TB in private health facilities tended to be higher than in public facilities even though most patients have earlier visits to private facilities than

public ones when they have cough. The study suggested that public health officials need to intensify active surveillance and clinician sensitization in both public and private institutions (Huong *et al* 2007) to help solve the problem of gap in identifying cases and when they are put on treatment (Uplekar & Rangan, 1993).

Again, the knowledge level of patients and what to do when they begin experiencing clinical features (Kassirer, 2010)of TB is very important. Another study which assessed patients who attend peripheral health facilities found increased knowledge about risk factors for TB among patients but were not equal for all patients (Kigozi *et al*, 2017). Recommendation from the study were that, strengthening education and more importantly making sure the information is accurate help in promoting sound TB knowledge and attitude among patients (Kigozi *et al*, 2017). This will also help address all misconceptions about the disease (Deribew et al., 2010).

2.4 Management of Tuberculosis

The WHO has five main components for TB management among which direct treatment of patients using short course chemotherapy (Espinal *et al*, 2000) is a key one. According to the NTP (2012) all newly diagnosed TB cases should be treated for a period of 6 months using fixed combination anti-tuberculous medicine. The treatment has two phases: intensive period which last for two months and a continuation period of 4 months. However, patients who fail treatment are put on 8 month treatment. During this period of treatment, each patient is supposed to have someone close to him/her (treatment supporter) to provide support in all forms to

the patient. During the period of treatment, sputum of the individual is collected at recommended intervals to ascertain if the person is responding to treatment favorably.

2.3.1 Treatment Outcomes

There are seven main treatment outcomes of TB treatment and include cure, treatment completed, treatment failure, defaulter or loss to follow up, transferred out and death (Espinal *et al*, 2000; Veen *et al*, 1998; WHO, 1997).The Ghana National TB control program however does not consider transferred out as a treatment outcome since all transferred cases need to continue with their treatment irrespective of where they end up (NTP, 2012). Treatment outcome shows the percentage of the total number of cases notified in a particular geographic location and the end result during or after the treatment (Veen *et al*, 1998).Veen *et al* pointed out that TB programs at all levels need to collect information on treatment outcome since it is very important in evaluating the program effectiveness.

2.3.1.1 Cure and Treatment completed

According to the NTP (2012), treatment outcome called cure means the patient was diagnosed as having sputum which showed the presence of *Mycobacterium tuberculosis* and was put on anti-tuberculous medicine for the expected number of months (6 or 8) and at the end of this period the laboratory result showed there are

no organisms present in the sputum. Veen *et al* (1997) similarly explained that if the sputum of a positive TB patient proves that there are no bacteria on two separate occasions and at the end of the entire treatment period, the person is declared cured.

A related treatment outcome term is treatment completed. This is defined as person whose sputum did not show the presence of tuberculous organism but all clinical features as well as chest x-ray shows greatly that the patient is having tuberculosis. This person is put on treatment for the required months (6 or 8) after which his sputum is examined. If the sputum results say it‟s negative, it is then concluded that he has completed the treatment (NTP, 2012).

Both terms - „cure and treatment completed‟- defines the success rate of TB control program and they are the desirable outcomes for treatment. The treatment success rate and adverse outcomes for Ghana for the period of 2005 to 2009 is presented in table 2.1.

Table 2.1: Ghana National Treatment Success and Adverse Rate, 2005 – 2009

Year	Treatment Success (%)	Adverse outcome (%)
2005	72.4	27.6
2006	74.5	25.5
2007	84.6	15.4
2008	85.4	14.6

2009	87.0	13.0

Source: NTP (2012)

TB treatment success improves year after year in Ghana.

In the study of large scale investigation of the impact of standard short-course chemotherapy in six countries, Espinal *et al* (2000) found a significantly higher percentage (83%) of clients with treatment success rate just a little below the WHO standard of 85% (WHO, 1997). The success rate for treatment since 1994 to 2005 has remained 80% and above (WHO, 2008). All programs therefore need to achieve 80% or more. For a patient to be declared cured from TB, Veen *et al* (1998) clearly explains that the bacterial strains must be susceptible to the drugs and patients must also adhere to the treatment protocol. Again, standard monitoring is essential in order to find out what percentages of notified cases have an outcome of cured at the end of the period of treatment.

2.3.1.2 Treatment failure and Defaulter or Loss to Follow Up

Another important outcome of treatment of TB is treatment failure and Defaulters. These are adverse outcomes in TB treatment. However, getting good data on these will help the TB program evaluate how successful and efficient it has been and the way forward. The NTP (2012) explained treatment failure as a tuberculosis patient whose initial sputum showed the presence of TB organisms and was put of the

standard treatment protocol but laboratory investigation at the end of the fifth month of treatment or at the end of the entire treatment period showed positive. The other side of the definition by the NTP is someone with smear results negative for TB organism for the initial diagnosis but just at the end of the second month of treatment or later, the laboratory investigation of the sputum showed positive. This treatment outcome is never desired and it is setback to the TB control program.

A more serious and highly unacceptable outcome of treatment is loss to follow up which formerly was referred to as defaulter (NTP, 2012). A patient is said to have defaulted treatment if he has collected TB drugs for eight weeks or more after registration and interrupted the drug administration for eight consecutive weeks or more (NTP, 2012). Defaulted patients need to be pursued because of the possibility of becoming resistant to the tuberculosis medications (Mitchison, 2005).

The defaulter and treatment failure rate varies from one geographical area to other. Whiles there is a relatively lower rate in some places, the rate is very high in some areas. In a study which focused on issues linked to loss to follow up cases in Nairobi region in Kenya by Muture *et al* (2011), as high as 945 who defaulted treatment, 215 and 193 stopped complying with the treatment regimen within the first and second months of initial treatment periods respectively. Among several reasons which this study revealed through interviewing the defaulters, factors such as ignorance, long travel time to treatment center, feeling better within the intensive phase, and side effects of the drugs, inadequate knowledge on tuberculosis, use of herbal preparation, alcoholism were all linked with causes of default. When any of these factors is present when the patient is on treatment, the possibility of failure in

treatment or defaulting is eminent. To solve some of these problems, Bronner *et al* (2012) in a study to assess the importance of follow up of patients concluded that, there should be trained individuals either health workers or not to trace all patients who miss any of the treatment appointment dates. This practice is likely to contribute to reduction in defaulters and treatment failures.

2.3.1.3 Death as a Treatment Outcome

A TB patient who dies during the period of treatment whether from TB or from any other cause has a treatment outcome as death (NTP, 2012). This is never welcome in the TB programs anywhere around the globe but it‟s highly

inevitable. Tuberculosis in itself can kill but there are other contributing factors which facilitates the death of these patients. One other disease condition which can easily influence death in TB patients is diabetes mellitus(Stevenson et al., 2007). This is true because diabetes weakens the immune system of the affected one thereby making him more vulnerable to the effects of tuberculosis. Similarly, Dooley et al (2009) also found a strong link between HIV and TB and point out that HIV is as a major risk factor for the death of TB patient. The possibility that an individual with HIV and TB will die earlier is higher than if the one is suffering from only Tuberculosis (Lawn et al, 2005). To add, Fielder *et al* (2002) found that delays in case detections and treatment may result in patient‟s death during treatment. Again, education and adherence to treatment is one sure way for reducing death in TB patients (Diefenbach-Elstob et al, 2017). In attempt to highlight if social

factors play any role in patients compliance to treatment in Papua New Guinea, Diefenbach-Elstob et al (2012) found that whiles some patients will readily accept that they have TB; majority attributes the clinical features to things like witchcraft so they do not accept early treatment. If TB death is found to cluster in a given geographic location, detail investigation need to be conducted to find out why and to recommend solution to remedy the situation.

2.6 Proximity of Directly Observed Therapy (DOTs) Centre and Treatment outcome

Geographical accessibility of patients to diagnostic center and DOTs is an important area of concern in tuberculosis management. Tadesse et al (2013) in their quest to establish any relationship between distance from the TB patients home and the financial constraints imposed on the patients as they travel to the treatment centres, information was collected from TB patients who received treatment from only two health centres out of the many health facilities which provides services to the public. These patients irrespective of their geographical location have to collect the TB medications daily for the two month intensive phase and weekly for the remaining four months of treatment. Tadesse et al (2013) found that most of the TB patients lived in rural communities which were not within easy reach of the health facilities. Walking longer distances affected the treatment process as patients became exhausted physically. This resulted in most clients preferring the traditional healer

system who were very close to them and with reduced financial burden. Even though this study did not use geographical information system to access the real problem of geographical accessibility, it concluded that geographical access and financial constraints were the major issues that affected the time of treatment initiation and compliance. A related study concluded that waiting for cases to come to the hospital rather than pursuing them in their homes and communities and again, not following up on the patients to find out if they are adhering to the right way of taking the medicines leads to negative treatment outcomes (Kolifarhood et al, 2015).

In a related study of factors that contributed to the occurrence of multi-drug resistant strains in Shanghai from 2009 to 2012, Li *et al* (2016) collected a total of 336 MDR-TB cases with special consideration on information such as age, gender, resident status, treatment history, treatment outcomes. The information on a TB clients geographical location and the nearest TB hospital, were coded on digital maps using the GIS to identify any statistically significant geographical clusters and whether there is any association of spatial and non-spatial variables on treatment outcomes. Li *et al* (2016) found a strong association between a TB client‟s residence and treatment outcome especially in the elderly. Clients who lived far from the TB hospitals clearly had difficulty in accessing care and had poor outcome of treatment.

Additionally, Tanser and Wilkinson (1999) in their study obtained the coordinates for all treatment points and plotted all the coordinates. It was revealed that with increased in the number of health facilities enrolled onto the DOTs program, there

was a reduction of 2.3 km travel distance to 1.5 km to access treatment. As more peripheral facilities including community –based health services and volunteers became part of the program, access to treatment improved significantly to 800m. This definitely improves access to treatment and also helps in reducing lost to follow up cases. However, analysis from a different study to ascertain the reasons for delay in care of patients, it was found that the distance to travel by a patient before accessing health care does not have any impact on tuberculosis management (Said et al., 2017). However, those who were closer mostly visit the care facilities very often than those who were very far. The distance however, did not result in delay in reporting symptoms suggestive of the disease (Said et al., 2017). The factor that however contributed to late reporting of cases was selfprescribed medicines which these patients use for long time before reporting. To curb this practice the same study suggested capacity building of service providers so that cases can be identified at the outlets for sale of such drugs.

2.7. Application of Geographical Information system in public health

One powerful automated ways of capturing, retrieving, and presenting spatial data is through the use of geographical information systems (Clarke *et al,* 1996). Vine, Degnan, and Hanchette (1997) defined GIS as a technology that uses computers to map and analyze volumes of data or information in the geographical framework. In the view of Clarke *et al* (1996) GIS is one of the innovative projects in public health and epidemiology which when well applied can help in analyzing public health problems and providing solutions. GIS even though may have some limitations, it has many useful functions such as calculating distance between geographic

locations, generating buffer area of required width around a point, line or area, and it also has the feature of selecting a map layer with a specific characteristic (Vine *et al*, 1997). Unfortunately, some epidemiologists are less concerned about evaluating disease distribution spatially and therefore make it difficult to measure disease risk which may provide insight into the cause of a health problem (Moore & Carpenter, 1999). However, John Snow, the father of field epidemiology used maps in developing hypothesis which led to the famous control of cholera in London in 1854 (Centers for Disease Control and Prevention, 2005).Gupta and Shriram (2004) list benefits of using GIS which include identifying the areas where cases are clustered and therefore are at a higher risk of the disease, forecasting epidemics, and monitoring disease trend and interventions over time. It is therefore prudent for every public health official to employ the services of GIS as a support in controlling diseases and other health events(Cromley & McLafferty, 2011).

To be successful in the use of GIS, Geospatial World (2009) buttress that modeling diseases occurrence using GIS can help in explaining spatial interactions, identify at risk areas for disease spread, predict how diseases spread, and target those areas for interventions (Geospatial World, 2009).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter of the study highlights on the methodology that was used to collect data for the study. The components of the chapter are the; research design, population of the study, the sampling procedures, instrumentation, data administration processes and data analysis procedures.

3.2 Study Design

Research is not just about a piece of writing with the aim of finding a truth but it has structure that need to be followed to help in solving problems that need permanent solution (De Vaus, 2001). In this particular study, the researcher used quantitative design in gathering the requisite retrospective data to describe the tuberculosis case distribution and outcomes of treatment as well as best ways of improving the TB control program in the study area. This study focuses on the spatial analysis of a health TB disease distribution and outcomes of treatment. It

has been suggested that the spatial study of a disease can be categorized into two areas– how diseases are spatially distributed throughout the population (Hay et al, 2004)and the accessibility to health services by those affected(Almudaris, 2011). This research is about measuring the distribution of diseases and the extent to which patients have access to quality care and how to improve upon tuberculosis control in the municipality (Oviasu, 2012).

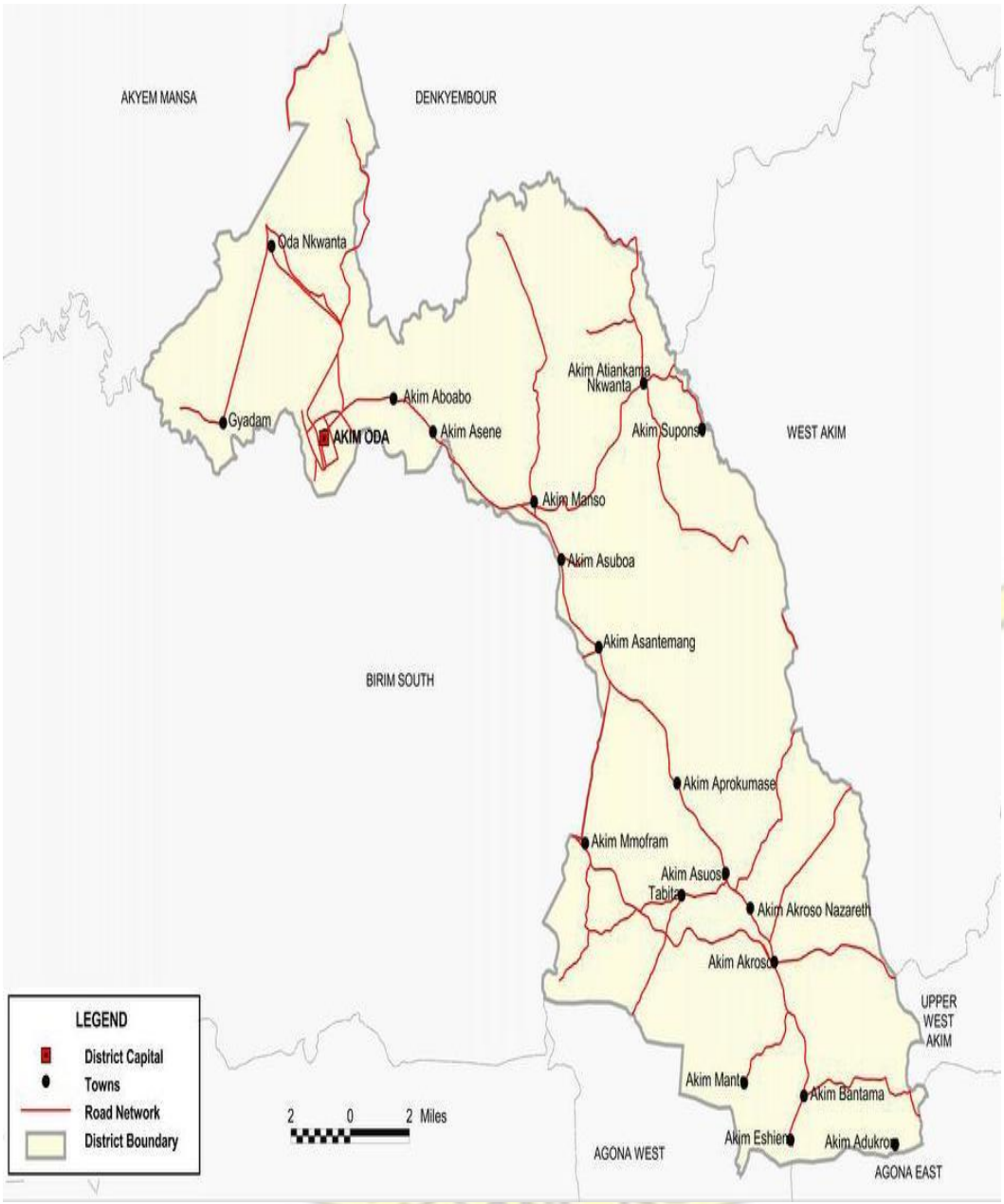
Quantitative methods can be applied in studies like this to describe the spatiality of health situations, and other existing health problems which need to be understood very well (Curtis et al, 2000).The use of quantitative approach such as in this research no doubt help in gathering large quantity of data to help describe a given phenomenon (Bryman, 2006).

Within the context of spatial research using the quantitative approach, there are two dimensions: the statistical aspect of the spatial data and the spatial modeling (Bradley & Schaefer, 1998). The aspect of statistics considers models such as analysis of variance and regression (Gelman et al., 2014). In order to understand every bit of modeling disease distribution, it is important to infuse geographical information system with quantitative methods so that disease situations which hitherto would have been difficult to understand or will obscure the researcher will become evident (Benko, 2014). Therefore, in order to make meanings of disease trends in a given geographic location, it is important to employ the functions of GIS so that data can be geoprocessed and analyzed for meaningful and critical decisions (Nuckols et al, 2004).

3.3 Study area

The BCM is one of the 21 administrative municipalities in the Eastern region of Ghana. The Municipality shares boundaries with five other districts in both Central Eastern regions and as shown in figure 3.1. Its bounded by Akyemansa in the North West, Kwaebibirim in North East, West Akim in East, Birim South in the West and Agona East (Central Region) in the South. The capital of Birim Central municipal is Akim Oda. The Municipal covers an area of 525.1727square kilometer. As many as 250 different communities with most of them in the rural areas are in the Municipality. Figure 3.1 and 3.2 shows map of the municipality showing all the major towns.

Figure 3.1: Neighbouring Districts of Birim Central Municipal



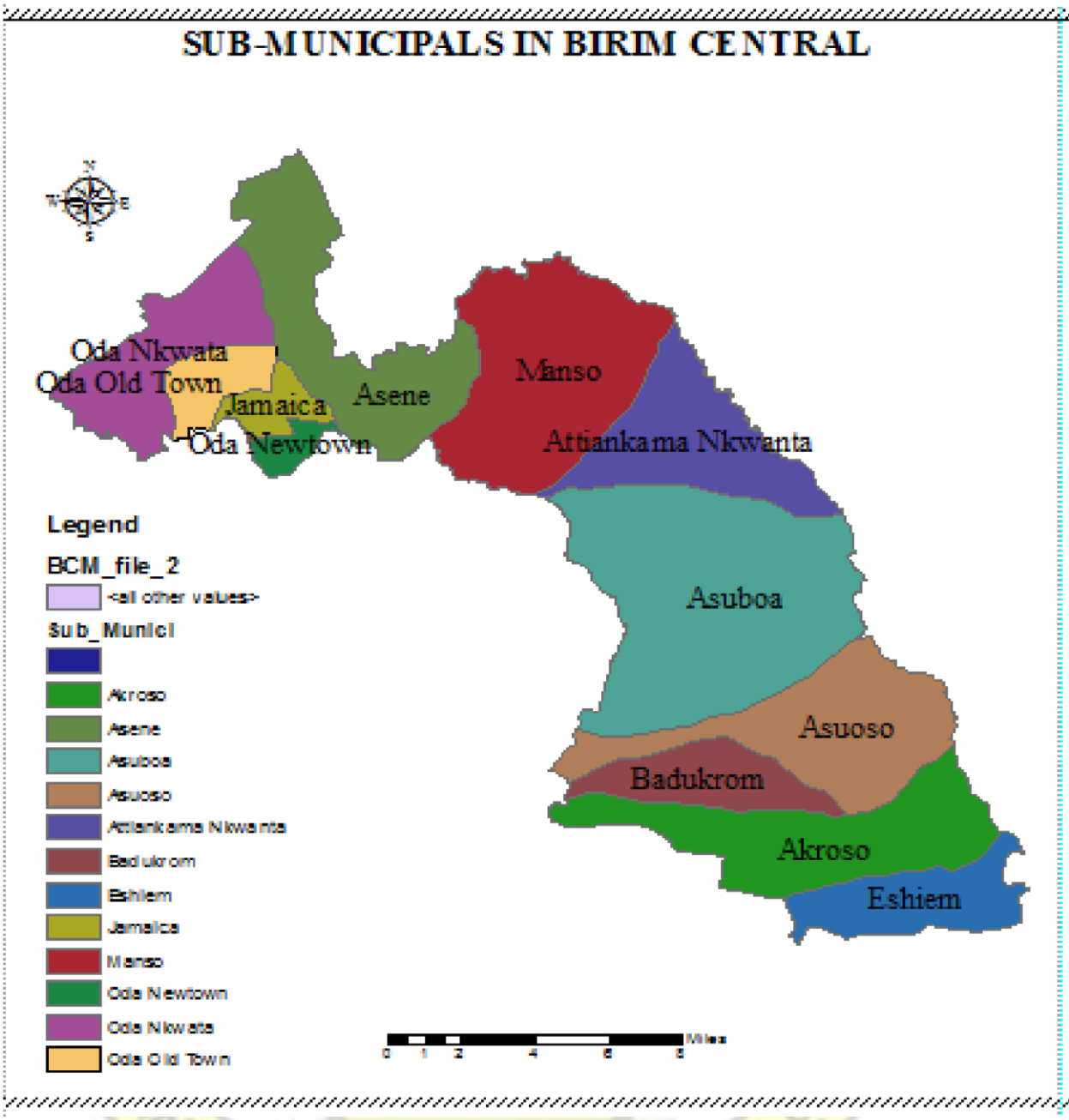


Figure 3.2: Map of Birim Central

The housing and population census organized in year 2010 indicated that the municipality has an estimated population of 170,813 people with an average population growth rate of 2.1%. Males account for 48.4% of the population whiles the remaining 51.6% are females.

There are three hospitals: Oda Government Hospital, Jubilee Hospital (private) and the Community Hospital (private) situated in the municipal capital, Akim Oda. The only Health Center in the Municipality is situate in Akroso and there are 19 CHPS compounds which are fully operational. In the private sector there are five clinics and a maternity home. Currently, there are two pharmacy shops and several other outlets for sale of legal medicines.

3.4 Study Population

A study population is the total number of individuals or items or elements that form part of the study (Horvitz & Thompson, 1952). The population included in this study is all TB cohorts in the Birim Central Municipality from 2012 to 2017 and all health personnel directly involved in TB care within the municipality.

3.5 Sample Size and Sampling Technique:

It is always difficult and time consuming to study the population in research. A representation of the population for the study therefore help in reducing cost and completing the study within a relatively short time(Lunsford & Lunsford, 1995).

In this study, the researcher adopted the purposive sampling technique to collect data sample from the population to be a representative of the population. The purposive technique was employed to select all TB cases reported from 2012 to

2016, all new TB cases recorded during the period of January – December in year 2017, and from all health staff who are directly involve with TB patients care. Persons directly involve in TB care include Municipal TB coordinator, institutional TB coordinators, and Community Health Officers in CHPS compounds designated to care for TB patients. By the nature of their work, they have wealth of knowledge in the area under study and can provide meaningful data. Considering the total number of TB cases recorded in the municipality and the number of health staff directly involved in TB care, the entire number which is 344 were all studied because this number is relatively small. The breakdown of the 344 which forms the study is as follows:

New TB cases recorded in 2017 - 56

Total number of health staff directly involved in TB control activities - 20

Total number of TB cases recorded from 2012 to 2016 -268

3.5.1 Inclusion criteria for TB cases

People diagnosed with TB regardless of age and resident in the Birim Municipal residents forms part of this study.

3.5.2 Exclusion criteria for TB cases

If an individual meets all the above criteria but not a Birim Municipal resident, such person, information on TB was not collected from them. Each study participant was screened for study eligibility prior to enrollment.

3.6 Data Collection Instrument

The researcher used two main instruments for data collection and these were the questionnaire and an inventory method. The study required the use of archived secondary data containing information on all the patients who were diagnosed and managed from 2012 to 2016.The records on patients contained information on demographics, TB treatment administered, TB-case category, daily attendance at the centre, and treatment outcome. Questionnaires were used to elicit information from the health staff and patients on their views on the proximity of health facilities and tuberculosis treatment outcome, and to recommend measures which help improve the control of tuberculosis in the municipality (See appendices A and B).

3.7 Procedure for Data Collection

This study involved the use of primary and secondary data to understand the distribution of TB cases and treatment outcomes as well as identifying the effect of patients‟ proximity to treatment centres and how to improve upon TB care in the municipality. The process involved reviewing patient data collected from 2012 to 2016 from the Municipal TB register. The municipal TB register contains all data on each patient including patients‟ demographics, residential details, tuberculosis type the patient suffered, treatment regimen, tuberculosis / HIV activities, as well as treatment outcome for each patient. A questionnaire survey was also conducted to elicit primary data from the newly diagnosed TB patients in year 2017 and health workers involve in TB control. The data gathered from the questionnaire

administered to these individuals as well as the health workers answers the second and third research questions of this study. Thus;

1. To what extent does proximity of health facilities to patients‟ location influence tuberculosis treatment outcome?
2. What measures can be put in place to improve the control of tuberculosis in the municipality?

For the GIS analysis, Birim Central Municipal base Maps were obtained from the GIS unit of the Ghana Statistical Service. The maps included Birim Central Municipal boundary, towns, settlements and road network maps. To gain access to the data, permission was sought from the Municipal Director of Health Services. Individual patient variables which are the subject of this investigation had to be extracted manually from the municipal TB register to record them into excel sheet. The extraction of TB data from the Municipal TB register lasted for one month with assistance from the Municipal TB coordinator. Secondly, after the questionnaire had been certified by the research supervisor for main data collection from the TB clients identified in year 2017, the same approval was given to go ahead with the data collection by the Akim Oda Municipal Health Directorate (see appendix D). Four research assistants were employed to help the researcher with data collection using questionnaire which in all, lasted for two weeks.

3.8 Analysis of Data

The data analysis was in two parts:

3.8.1 Part 1: Questionnaire Analysis

The analysis was done using the statistical software SSPS. The information gathered from the questionnaire was first checked for clarity of expression and accuracy. The raw data was then organized, bearing in mind the research questions for which the instruments were designed. This was the manual analysis procedures, which included coding of the responses whereby each of them was given code numbers for easy input into the electronic software SPSS. After all the responses had been duly coded, they were keyed into the variable view of the SPSS using the coding key. Upon completion of this process, the next step was the keying of all the individual responses from the questionnaire process. When everything was over, frequency tables and charts and bars were extracted for the discussion in chapter five.

3.8.2 Part 2: Geo-Spatial Analysis

After accessing the patients‟ records and more importantly, their address to enable locating their homes, their individual locations were geographically coded on the Birim Central municipal base maps. The geo-coded data created from the hospital records were exported into the ArcGIS 10.2 software and overlaid with Birim Central Municipal base maps (shape file format). The description of the data spatially was in the view to understand space patterns and relationships (Wise et al., 1995).Two approaches to analyzing the data spatially were undertaken and include network analysis and evaluating the density of distribution of tuberculosis and treatment outcomes using choropleth maps(Colantonio et al., 2011).

3.9 Visualizing spatial data using choropleth maps

In order to map the number of tuberculosis cases and treatment outcomes in the study area, the researcher used the choropleth maps. The map actually brought out clearly the areas with concentration of tuberculosis in the study locality. Again, the map brought to light communities who are at higher risk of tuberculosis (hot spots) and those with relatively lower risk as well as areas where there are highly positive tuberculosis treatment outcomes in the Municipality (Mills et al, 2011).

3.9. 1 Network analyses

In order to partly answer the second research question (to what extent does proximity of health facilities to patients" location influence tuberculosis treatment outcome?), network analysis was done and it included location –allocation and service area analysis which were all undertaken using the ArcGIS 10.2

3.9.2 The Service Area analysis

In order to ascertain how easy or difficult TB patients get access to treatment points in the municipality, the service area analysis was employed. Evaluating the distance travelled by patients to health facilities and the spatial distribution of cases within the municipality help to assessed the impact this will have on outcomes of treatment (Huang et al, 2009). This will highly contribute to improvement in the TB control program in the municipality because it will help ascertain whether persons who are highly at risk of the disease actually get access to health care easily(German et al.,

2001).Most often, accessibility to health care is considered in terms of travelling time and distance from patients home. This was used to determine accessibility of TB patients to heath facility (Apparicio et al, 2008).

3.10 Reliability and Validity:

It is always important to ensure that the data collection instruments measure what it is intended to measure at all times and yield same results in different locations (Kimberlin & Winterstein, 2008). To achieve this, care was taken in the design of the data collection tool. To further authenticate the data collection tool, the researcher sought information and direction from the experts regarding the reliability of research instruments for the data collection. The instrument was given to the supervisors in the Department of Computer Science (KNUST) and the Municipal Director of Health Services in Birim Central who are experts in that field for vetting. The data collection tool was also pre-tested (Gould, 1996) in the Birim South district which has similar characteristics as the Birim Central municipality - more importantly, in terms of culture, geography, and demographics of the TB patients. Necessary corrections in the data collection tools were thereafter made.

3.9 Ethical Considerations:

The researcher sought approval for the use of the study site from the Municipal Director of Health Services, Birim Central. All individuals who took part in the study were told about the aim, the purpose of the study and the benefits from the

study. A consent form was presented to each of the study participant answering the questionnaire (see annex C).

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.0 Introduction

This chapter presents the results that emerged from the data collection process. The presentation of results has been done in two main parts: the first part is devoted to the biographical information of respondents and the second part presents the main research results according to the research questions. It must be stated that the data is primarily presented in tables and charts but few of the responses were presented in prose.

4.1 Biographical Information of TB Patients

This section presents the biographical variables of the patients. The biographical data are based on selected variables which included sex and age. A total number of fifty six (56) questionnaires were distributed to the TB patients but only fortyfive (45) were received. The rest of the data on health staffs directly involved in TB care and details of TB patients retrieved from the TB registers for the periods of 2012 to 2016 were analyzed separately.

4.1.1 Gender Distribution of TB Patients

Data collected on gender for this study showed majority of the TB clients, 26 (58%) were males and the rest females. This data indicates a significant proportion of TB cases in the municipality being males.

4.1.2 Age Distribution of TB Patients

The ages of TB Patients were captured and the responses given are presented in Table 4:1.

Table 4.1:Distribution of respondents by age

Age in years	**Responses TB Patients (%)**
Up to 40	29 (64)
Above 40	16 (36)
Total	45 (100)

Source: Field Survey

4.1.3 Marital Status of Respondents

Out of the forty five (45) respondents, 23 representing 51 percent of the total number were married, 3 were widowed, whereas 18 respondents representing 40% also were single.

Table 4.2: Marital Status of Respondents

Age in years	Responses (%)
Married	23 (51)
Widowed	3 (9)
Single	18 (40)
Total	45 (100)

Source: Field Survey

The distribution of respondents by educational status is presented in table 4.3.

Table 4.3: Educational background of respondents

Educational background	Frequency	Percentage
No formal education	15	33.3
up to junior high	19	42.2 11
S. H. S	5	13.3 **100**
Tertiary	6	
Total	**45**	

Source: Field Survey

From Table 4.3, 19(42.2%) of the respondents had up to junior high school education while 15 (33.3%) of them had no formal education and 5 (11%) of them had SHS education, and only 6 (13.3%) had tertiary education.

Regarding the occupation of respondents, figure 4:1 shows the distribution of respondents' occupation. Most of the patients‟ 16 (36%) were farmers, salaried employees were 3 (7%), traders were 11, students were 6 and unemployed 5 (11%).

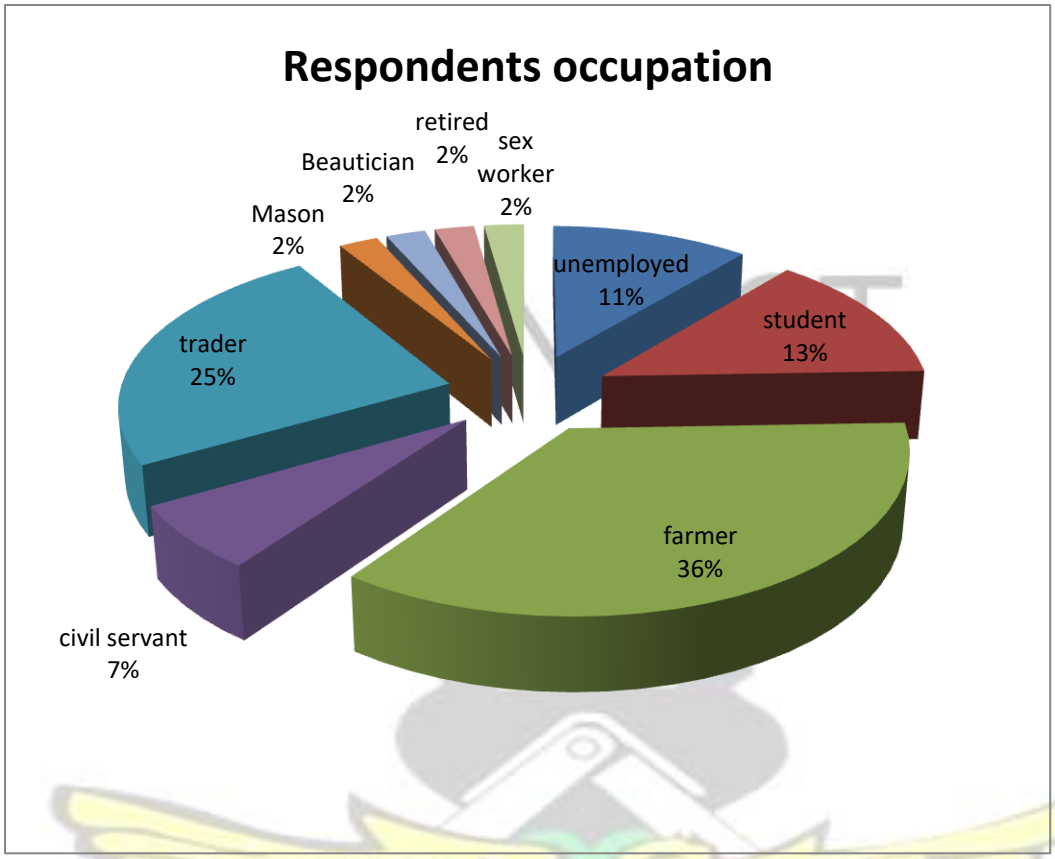


Figure 4:1

Source: Field Survey

It is good to note from figure 4.1 that most patients (89%) were involved in an economic activity with only 11% unemployed.

4.2 Background Information of Health Staff

The total number of questionnaire sent to health staffs who are directly involved in TB care was 20 but only 13 answered the questions. In an attempt to find out where these health staffs provide their TB care, their responses are illustrated in figure 4.2.

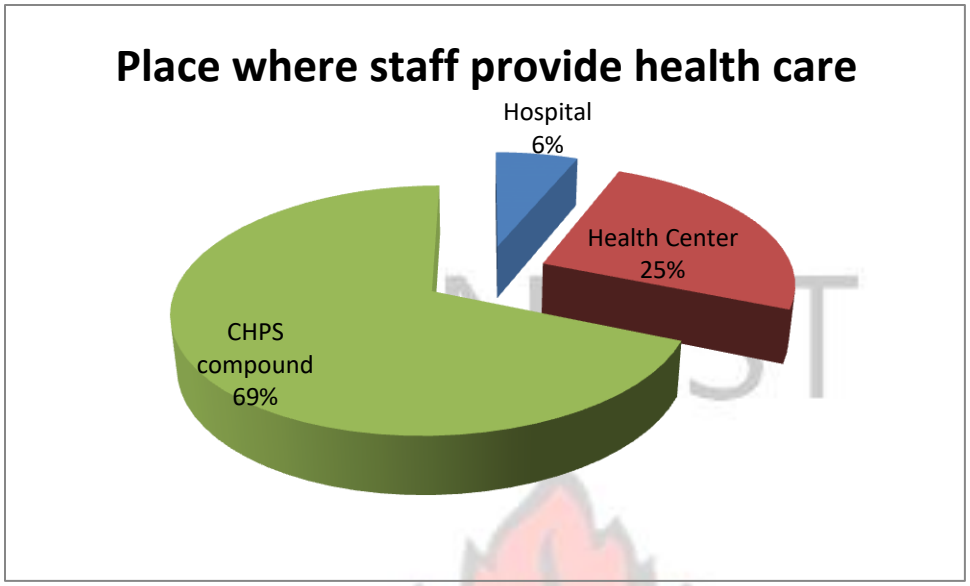


Figure 4:2 Source: Field Survey

The CHPS compounds seem to be very crucial in TB care as majority of the respondents (69%) provides their TB care services there. The various roles played by the health staff in TB care are presented in table 4.4.

Table 4.4: Health Staff Role in TB care

Role in TB care	Frequency
Municipal TB coordinator	1
Institutional TB coordinator	4
Patient records management only	2
Patient treatment and follow up	9
	13

Source: Field Survey

4.3 The spatio-temporal distribution pattern of tuberculosis cases and treatment outcomes in the Birim Central Municipality from 2012 to 2016

This section illustrates the spatial distribution of TB cases identified for the years 2012 to 2016 in the Birim Central municipality. Visualizing the distribution of cases is an important aspect of epidemiological studies. This helps to generate hypothesis useful to identify factors influencing patterns of diseases. The use of maps to communicate how a given disease is distributed is helpful in identifying persons at high risk.

4.3.1 Demographics of cases

A total of 268 TB cases were reported during the five years of study. The breakdowns of the cases by the various years were:

Year 2012 - 59 cases,

Year 2013 – 57 cases

Year 2014 – 43 cases

Year 2015 – 52 cases

Year 2016 - 57 cases

Although there was a decline in the total number of cases for the year 2014 as compared to year 2012, the cases are seen to rise again in the years 2015 and

2016. Of the total TB cases, 201 (75% of the total cases) were smear positives cases (PTB+) while 67 (25% of the total cases) smear negative (PTB-) and 7 (3% of the total cases) were extra-pulmonary tuberculosis (EPTB).

This explains that in the Birim Central Municipality majority of patients who are diagnosed with TB are pulmonary smear positives (PTB+). The distribution of TB cases by communities is presented in table 4.5 while the spatial distribution has been illustrated in the figures 4.3 to 4.9.

Table 4.5: Community Distribution of Incidence of TB cases from 2012-2016

Community	2012	2013	2014	2015	2016	Total	Comm. Pop	Prev. (Per 1000)	Treatment Health Facility
Aboabo	2	3	1	1	4	11	4738	2.3	Aboabo CHPS
Akroso	6	1	5	8	8	28	13023	2.2	Akroso HC
Aprokumase	0	1	2	1	2	6	1215	4.9	Asanteman g CHPS
Asanteman	2	2	0	1	0	5	6215	0.8	Asanteman g CHPS
Asene	5	8	0	2	6	21	7748	2.7	Asene CHPS
Asuboa	1	7	1	3	2	14	7569	1.8	Asuboa CHPS
Asuoso	2	1	3	1	0	7	7432	0.9	Asuoso CHPS
Atiankama	5	2	2	2	5	16	7140	2.2	Atiankama CHPS
Badukrom	0	0	0	1	0	1	4080	0.2	Badukrom CHPS
Bantama	1	0	0	0	0	1	1057	0.9	Bantama CHPS
Eshiem	1	2	2	1	0	6	2584	2.3	Eshiem CHPS
Essam	0	0	0	0	1	1	2103	0.5	Essam CHPS
Gyadam	0	0	2	2	0	4	3573	1.1	Gyadam CHPS
Manso	1	1	3	0	3	8	8559	0.9	Manso CHPS
Nyame Nti	0	0	0	0	1	1	4593	0.2	Nyame Nti CHPS
Oda	18	20	7	17	15	77	50163	1.5	Oda Hospital
Oda Nkwanta	3	0	3	0	3	9	6793	1.3	Oda Nkwanta CHPS
Old Town	12	9	12	11	7	51	16200	3.1	Old Town CHPS
Tabita	0	0	0	1	0	1	2856	0.4	Tabita CHPS
Total	59	57	43	52	57	268	157641	1.7	

Source: Field survey

The period prevalence of all forms of TB from year 2012 to 2016 in the municipality is presented in figure 4.3

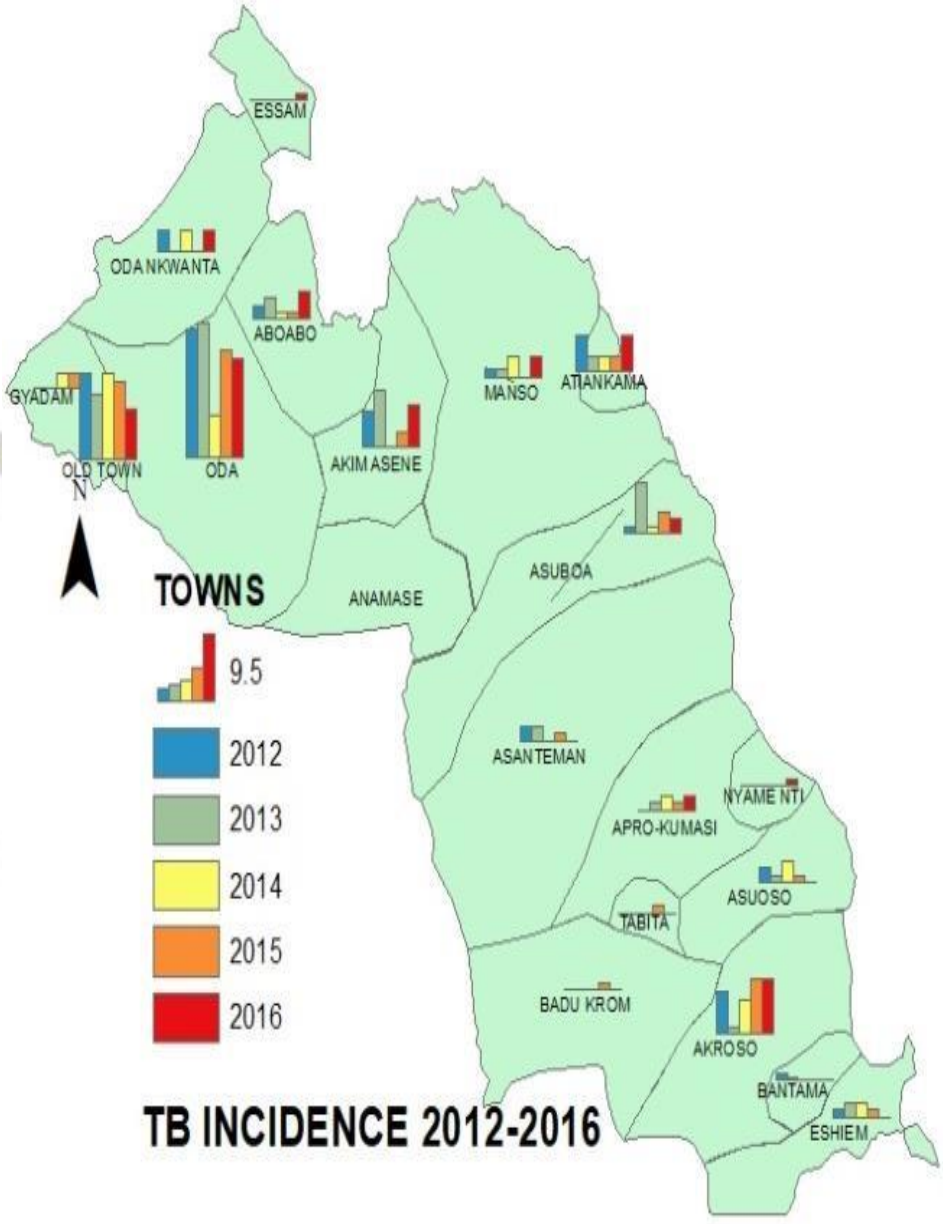
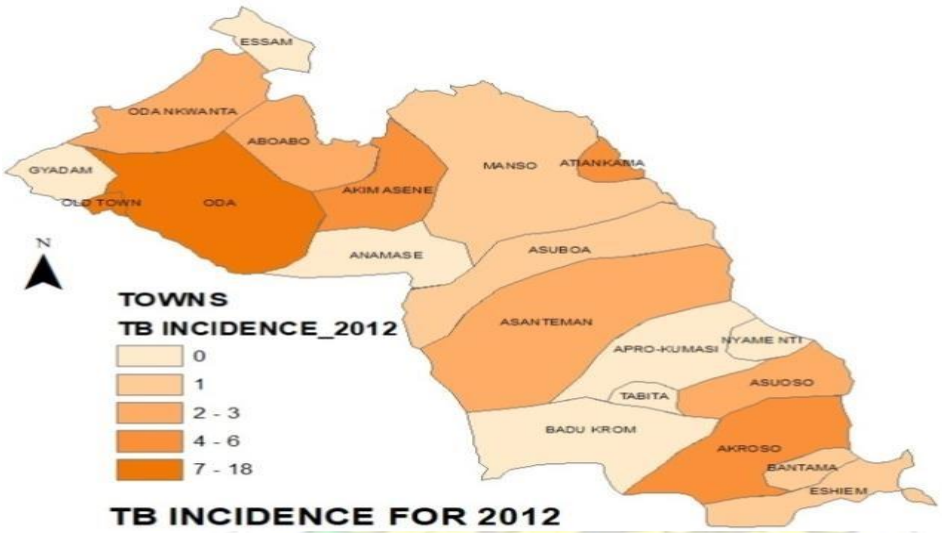


Figure 4:3 Source: Field Survey

Figure 4:3 gives the spatial distribution of TB cases from 2012-2016 for the Municipality. Figures 4:4 to 4:8, also shows the yearly distribution of TB for the municipality. The yearly distribution shows the TB hot spots in the municipality which are mainly the Akim Oda and Old Town, for the study period. These two areas are next to each other; therefore further studies need to be conducted into this.



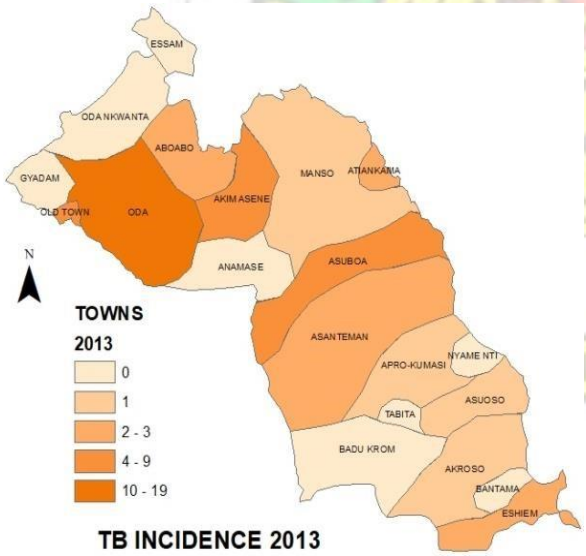
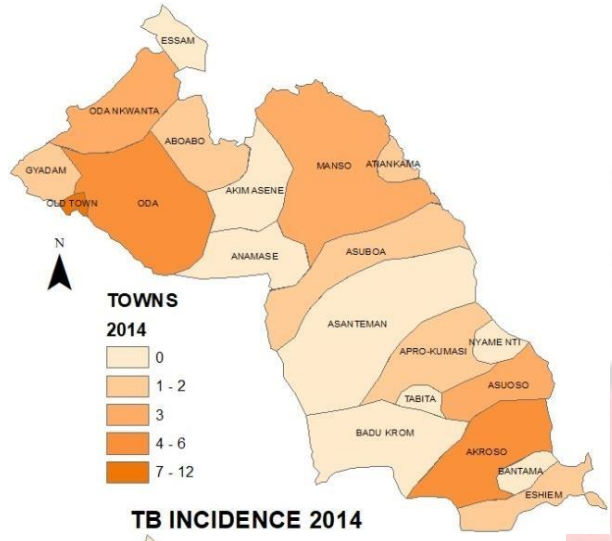


Figure 4:5



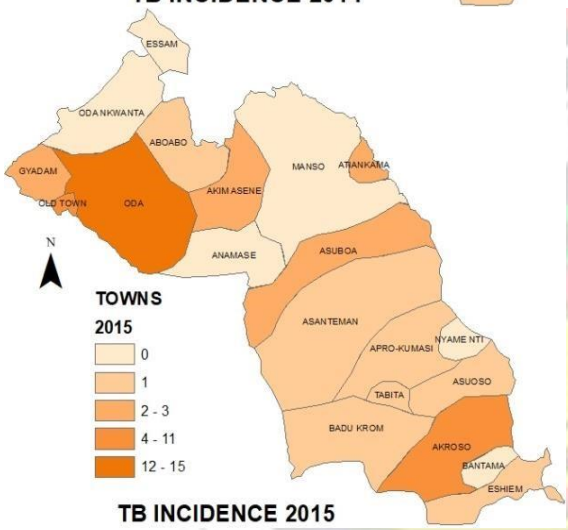


Figure 4:7

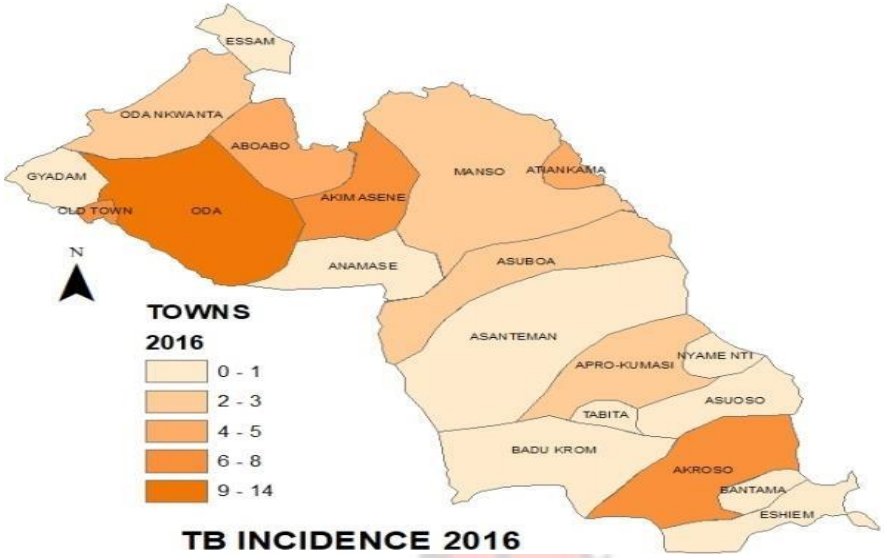


Figure 4:8 Source: Field Survey

The distribution of cases managed in the various health facilities is illustrated in figure 4.9

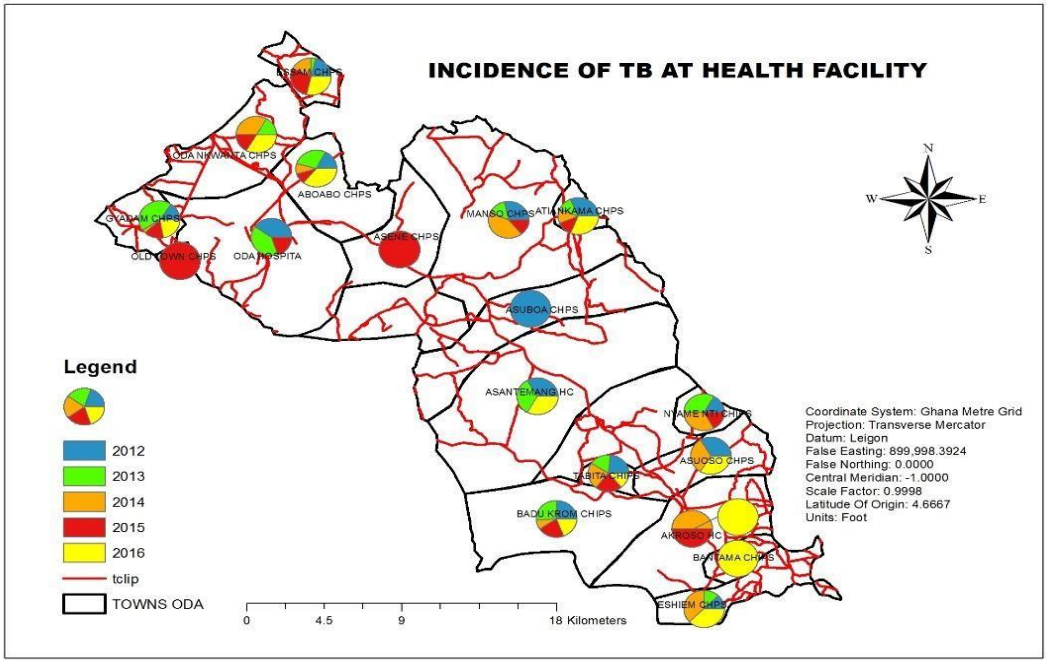


Figure 4.9: Cases Managed in Health Facilities, 2012 – 2016, BCM

The one sample test for temporal distribution of TB cases identified from 2012 to 2016 is presented in table 4.6

Table 4. 6: One-sample test for temporal distribution of TB cases 2012-2016

	Test Value = 0					
	t	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
VAR 2012	12.015	57	.000	10.03448	8.3621	11.7069
VAR 2013	9.388	57	.000	9.03448	7.1074	10.9616
VAR 2014	10.777	57	.000	5.51724	4.4921	6.5424
VAR 2015	10.968	57	.000	8.37931	6.8494	9.9092
VAR 2016	13.141	57	.000	8.03448	6.8101	9.2588

The measures of central tendencies and dispersion is presented in table 4.7

Table 4.7: Measures of dispersion and central tendencies

	VAR2012	VAR2013	VAR2014	VAR2015	VAR2016
Mean	10.0345	9.0345	5.5172	8.3793	8.0345
N	58	58	58	58	58
Std. Deviation	6.36042	7.32926	3.89890	5.81838	4.65650
Sum	582.00	524.00	320.00	486.00	466.00

4.4 Treatment Outcomes of TB

Out of the 268 TB cases recorded during the five years, 16 of the patients died, 179 were cured, 53 completed treatment, 7 were transferred out, 3 were treatment failures and 7 defaulted in seeking treatment. The spatial distribution of TB

treatment outcome has also been mapped for the municipality. Table 4.8 shows the treatment outcome table for the municipality. Figures 4:11 to 4:18 shows the general and specific outcomes for each of the communities in the municipality where TB was identified.

Table 4.8: Treatment outcome for the Birim Central municipality, 2012-2016

Community	population of Catchment area	Died	Per 100 000	Cured	Per 100 000	Completed	Per 100 000	Defaulted	Per 100 000	Treatment failure	Per 100 000

Aboabo	4738	1	21	7	148	1	21	1	21	0	0
Akroso	13023	1	8	22	169	8	61	0	0	0	0
Aprokumase	1215	0	0	8	658	1	82	1	82	0	0
Asantemman	6215	0	0	5	80	0	0	0	0	0	0
Asene	7748	0	0	13	168	6	77	0	0	0	0
Asuboa	7569	1	13	7	92	2	26	0	0	0	0
Asuoso	7432	0	0	5	67	0	0	0	0	0	0
Atiankama	7140	0	0	10	140	3	42	2	28	0	0
Badukrom	4080	0	0	1	25	0	0	0	0	0	0
Bantama	1057	0	0	2	189	0	0	0	0	0	0
Eshiem	2584	2	77	2	77	0	0	1	39	1	39
Essam	2103	0	0	5	238	0	0	0	0	0	0
Gyadam	3573	0	0	2	56	0	0	0	0	0	0
Manso	8559	1	12	6	70	0	0	1	12	0	0
Nyame Nti	4593	0	0	2	44	0	0	0	0	0	0
Oda	50163	4	8	45	90	16	32	3	6	2	4
Oda Nkwanta	6793	1	15	4	59	5	74	0	0	0	0
Old Town	16200	4	25	32	198	11	68	1	6	0	0
Tabita	2856	0	0	1	35	0	0	0	0	0	0
Total	**157641**	**15**	**10**	**179**	**114**	**53**	**34**	**10**	**6**	**3**	**2**

Source: Field Survey

The outcome of TB cases managed in the various health facilities in the different communities where these cases are coming from is presented in figure 4.10. Note that the health facilities in these different communities are named after them.

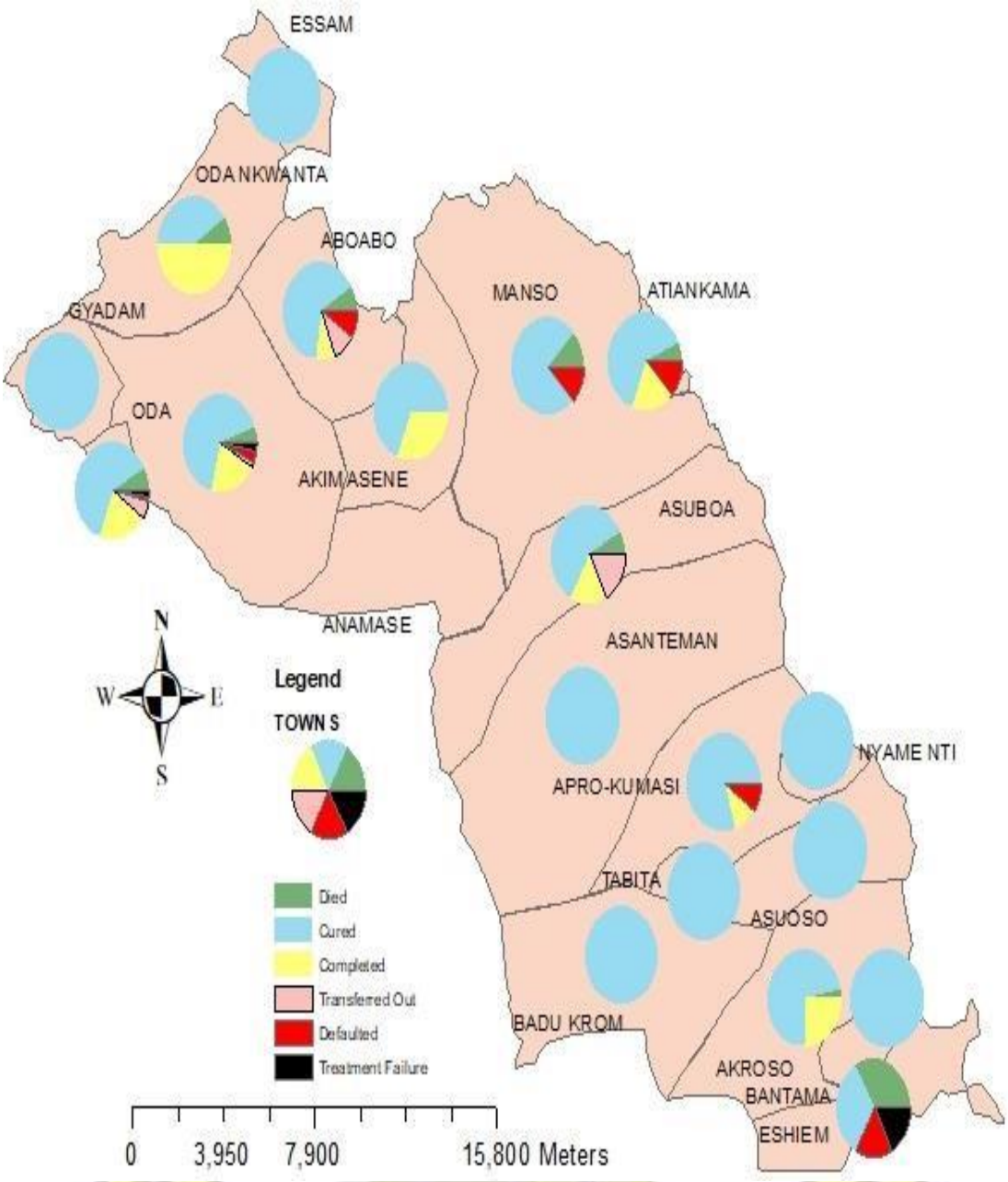


Figure 4.10: TB Treatment Outcome by Health Facilities 2012 – 2016, BCM

Source: Field Survey

Details of the various treatment outcomes of the different geographic areas are presented in figures 4.11 to 4.18.

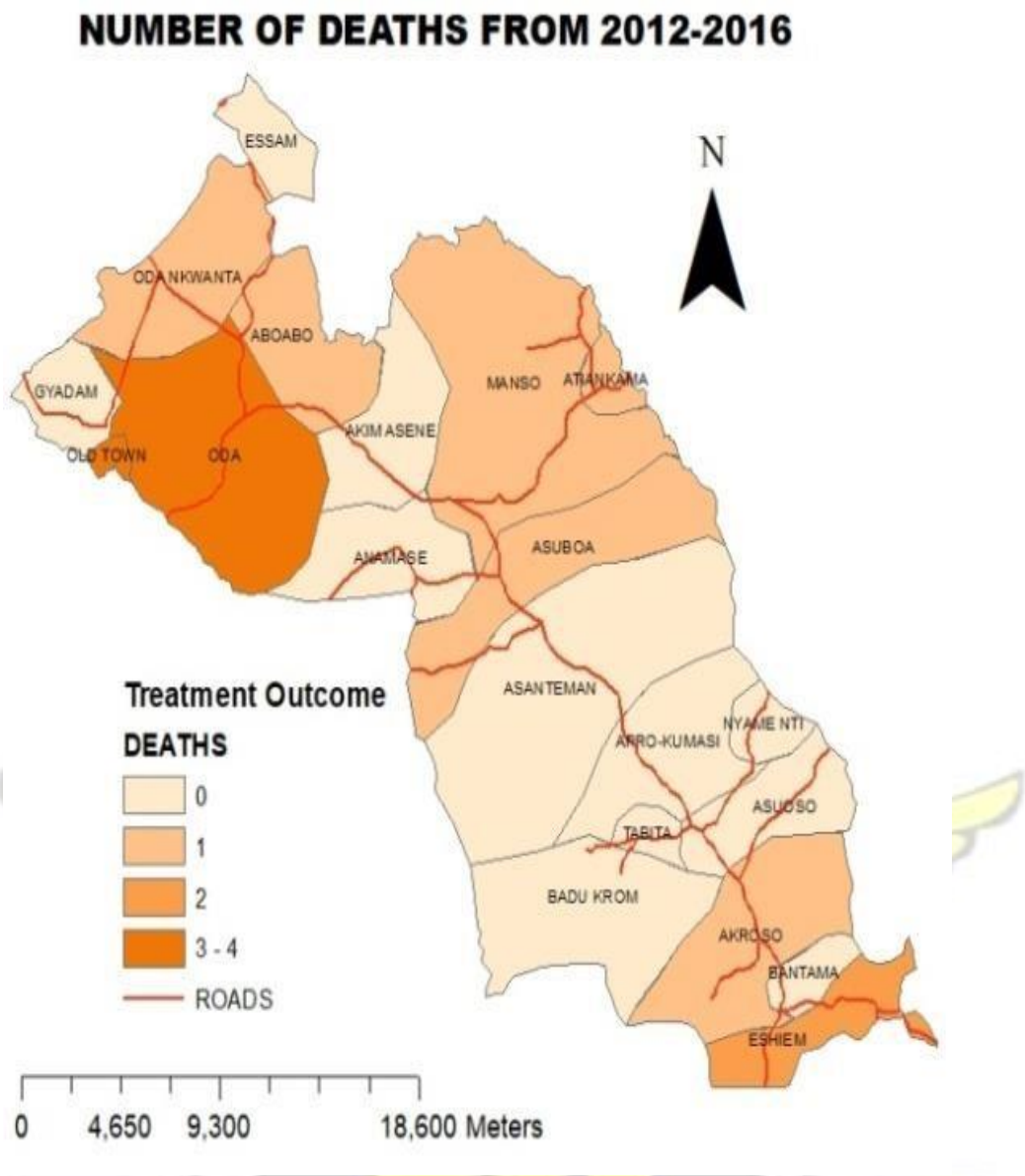


Figure 4.11: TB deaths distribution 2012-2016 Source: Field survey

The cured rate of TB cases managed in the various health facilities in the different communities where the cases are coming from is presented in figure 4.12. Note that the health facilities in these different communities are named after them.

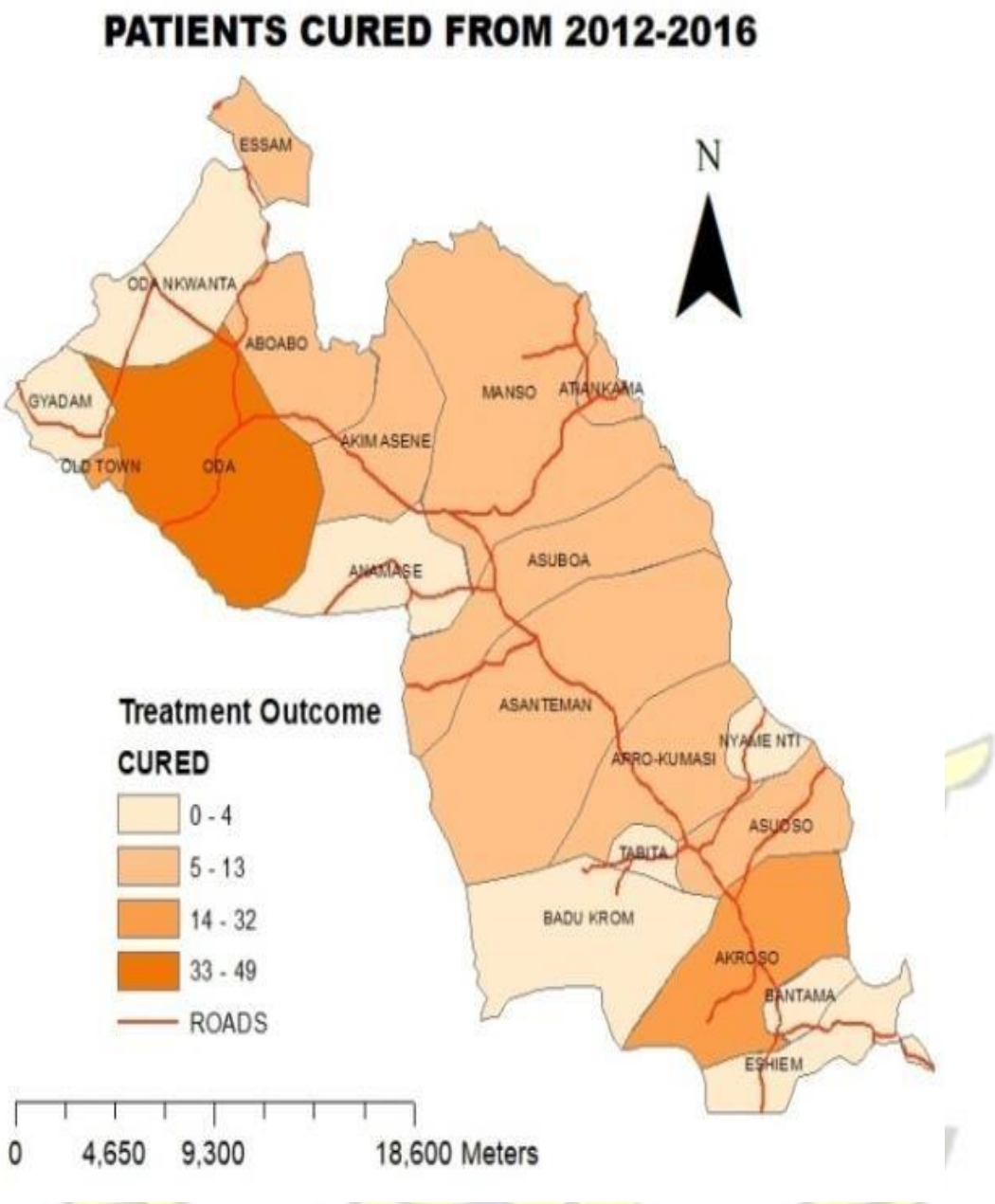


Figure 4.12: Distribution of cured TB cases 2012 – 2016 Source: Field survey

The treatment completed rate of TB cases managed in the various health facilities in the different communities where the cases are coming from is presented in figure 4.13. Note that the health facilities in these different communities are named after them.

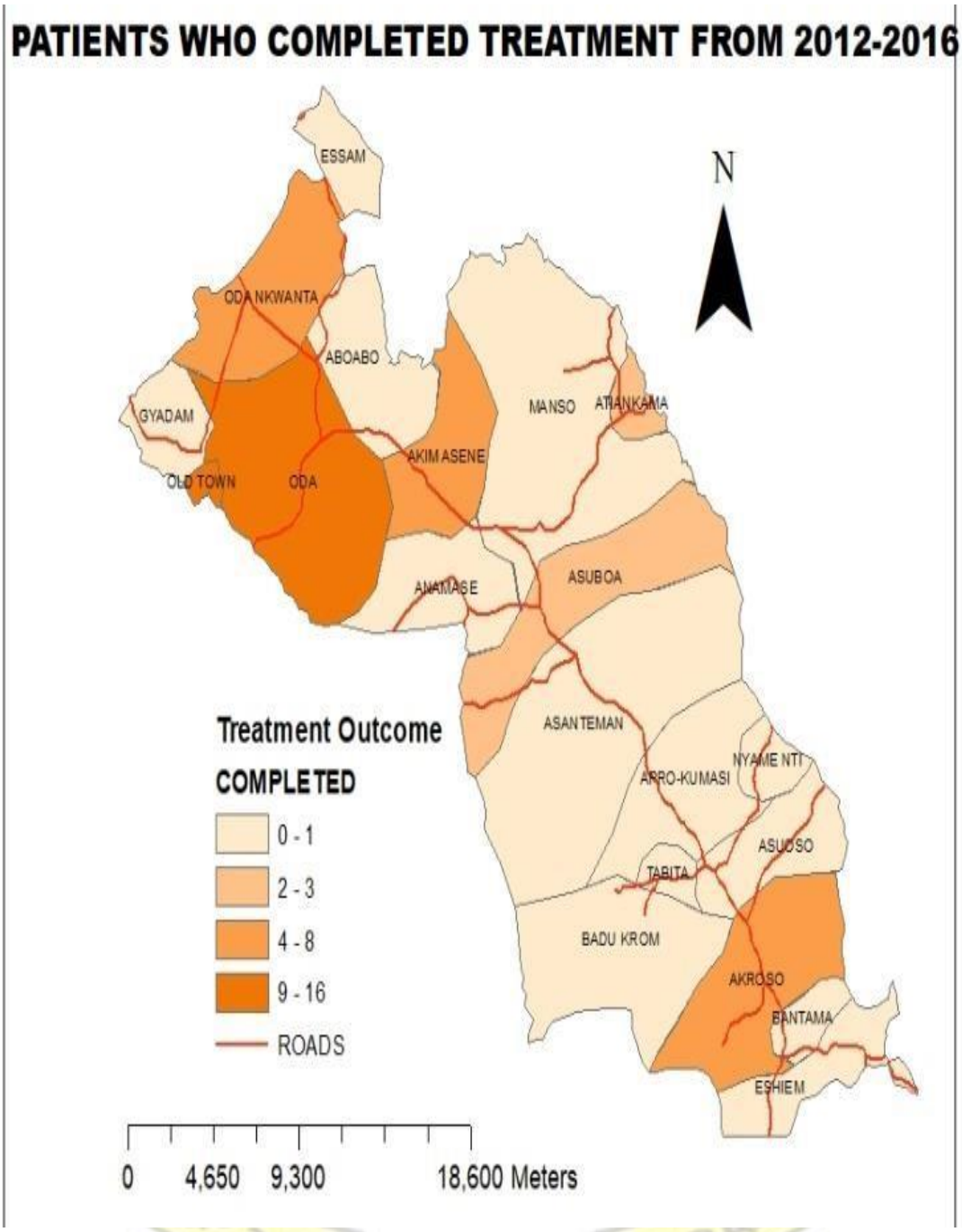


Figure 4.13: Distribution of TB treatment completed 2012-2016 Source: Field Survey

Patients who defaulted during treatment from 2012-2016 is presented in figure 4.14

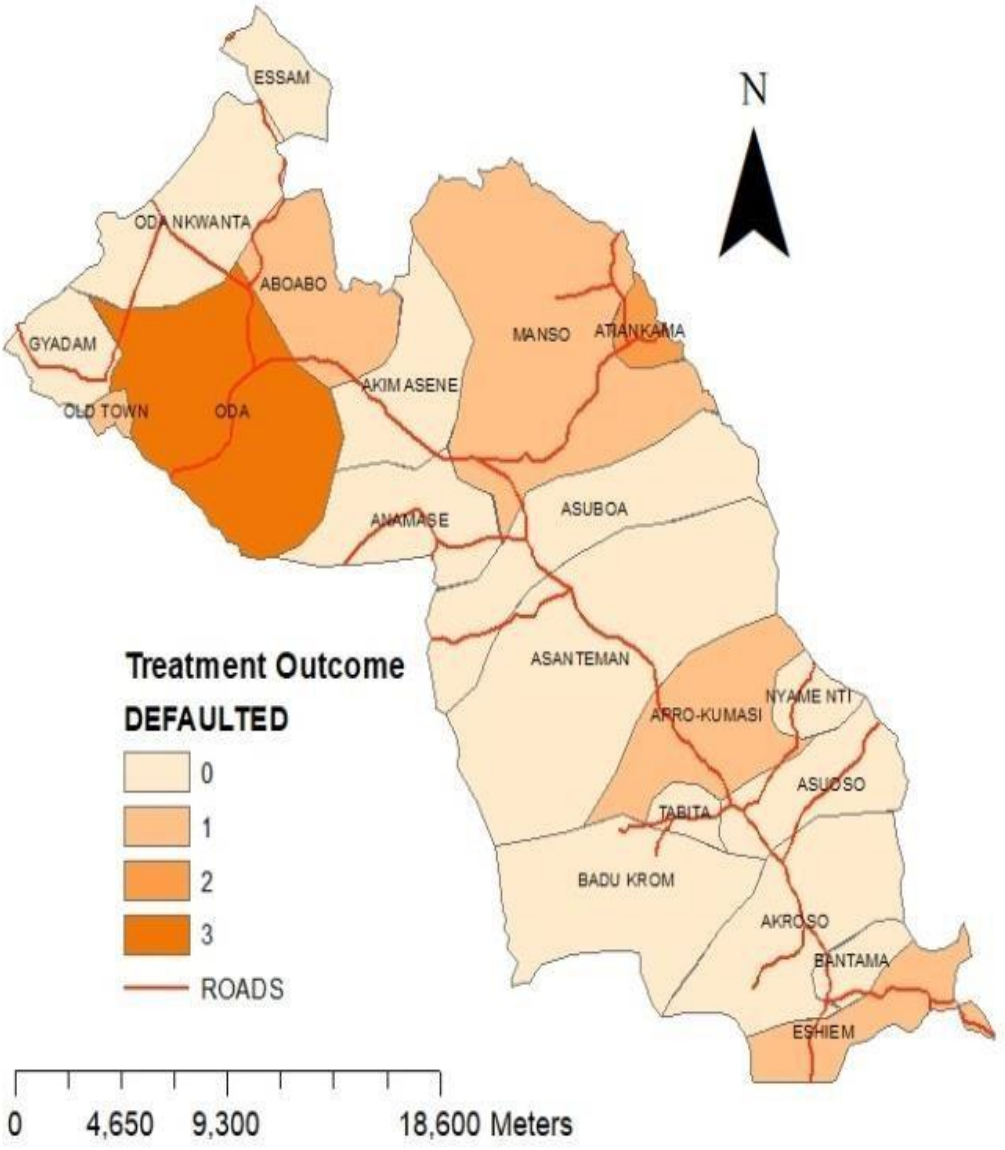


Figure 4.14: Defaulters distribution 2012-2016 Source: Field Survey

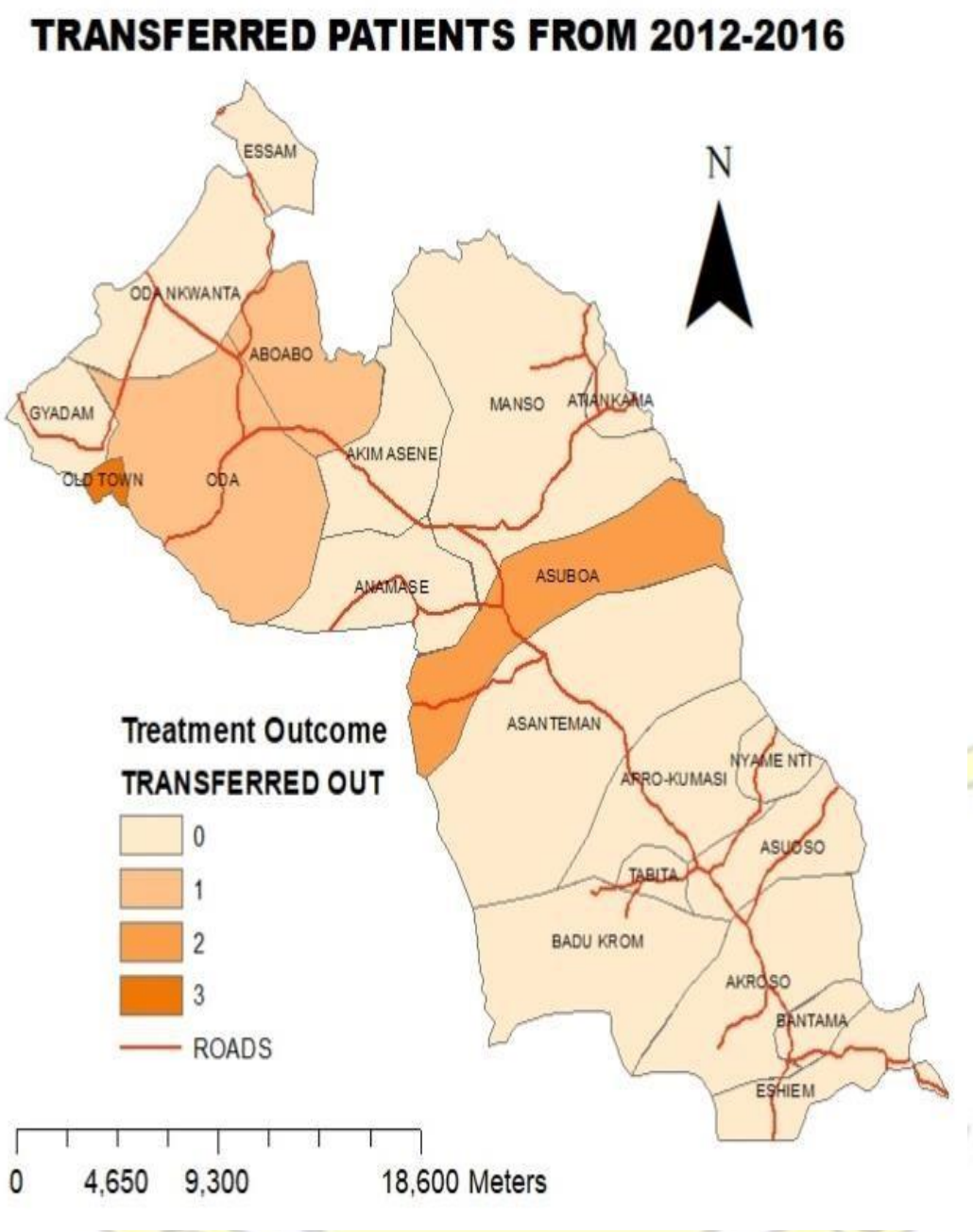


Figure 4:15: Transfer out distribution 2012-2016 Source: Field survey

The defaulter rate of TB cases managed in the various health facilities in the different communities is presented in figure 4.16. Note that the health facilities in these different communities are named after them.

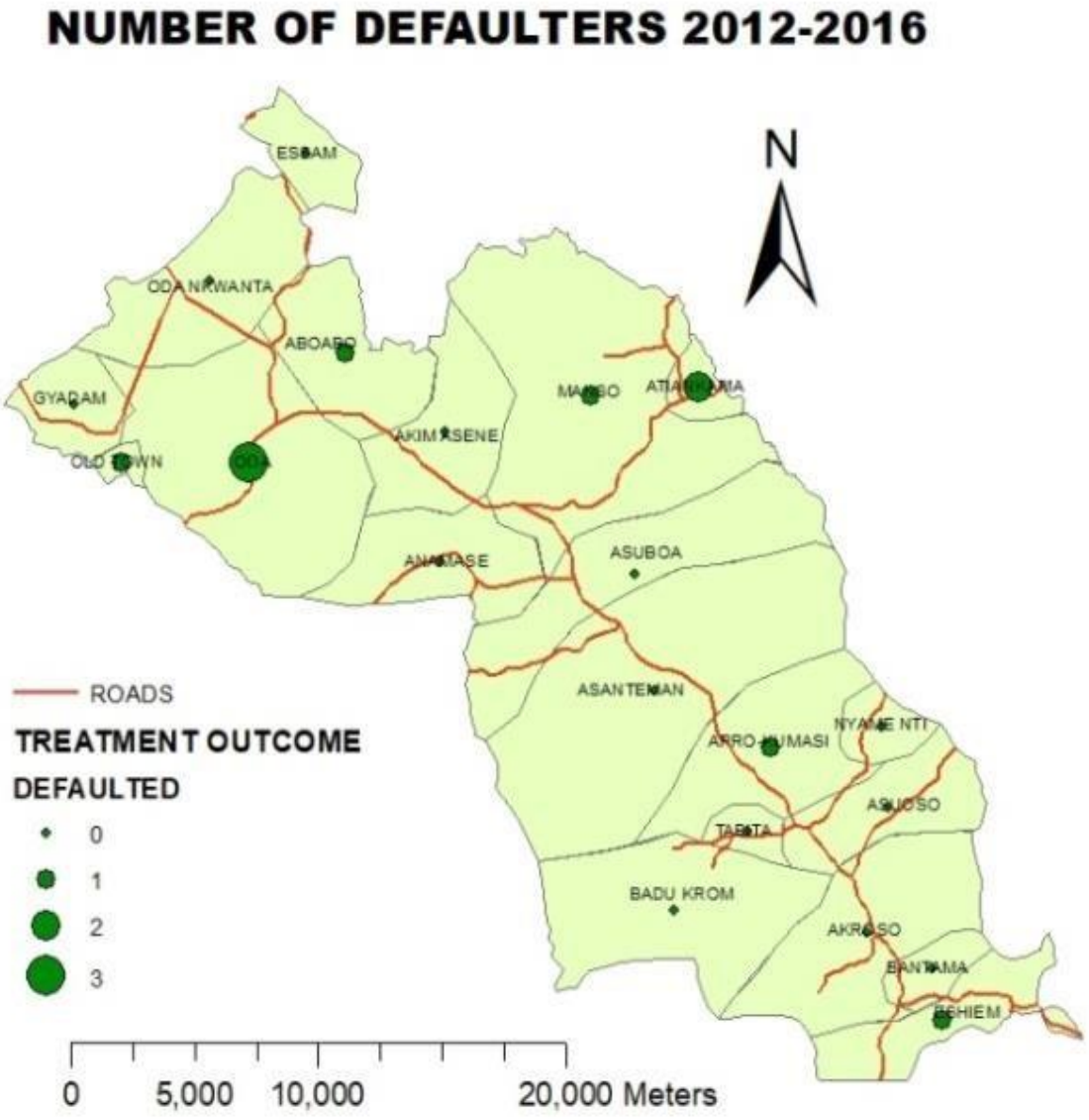


Figure 4.16: Defaulters distribution 2012-2016

Source: Field survey

The death rate of TB cases per the various health facilities in the different communities is presented in figure 4.17. Note that the health facilities in these different communities are named after them.

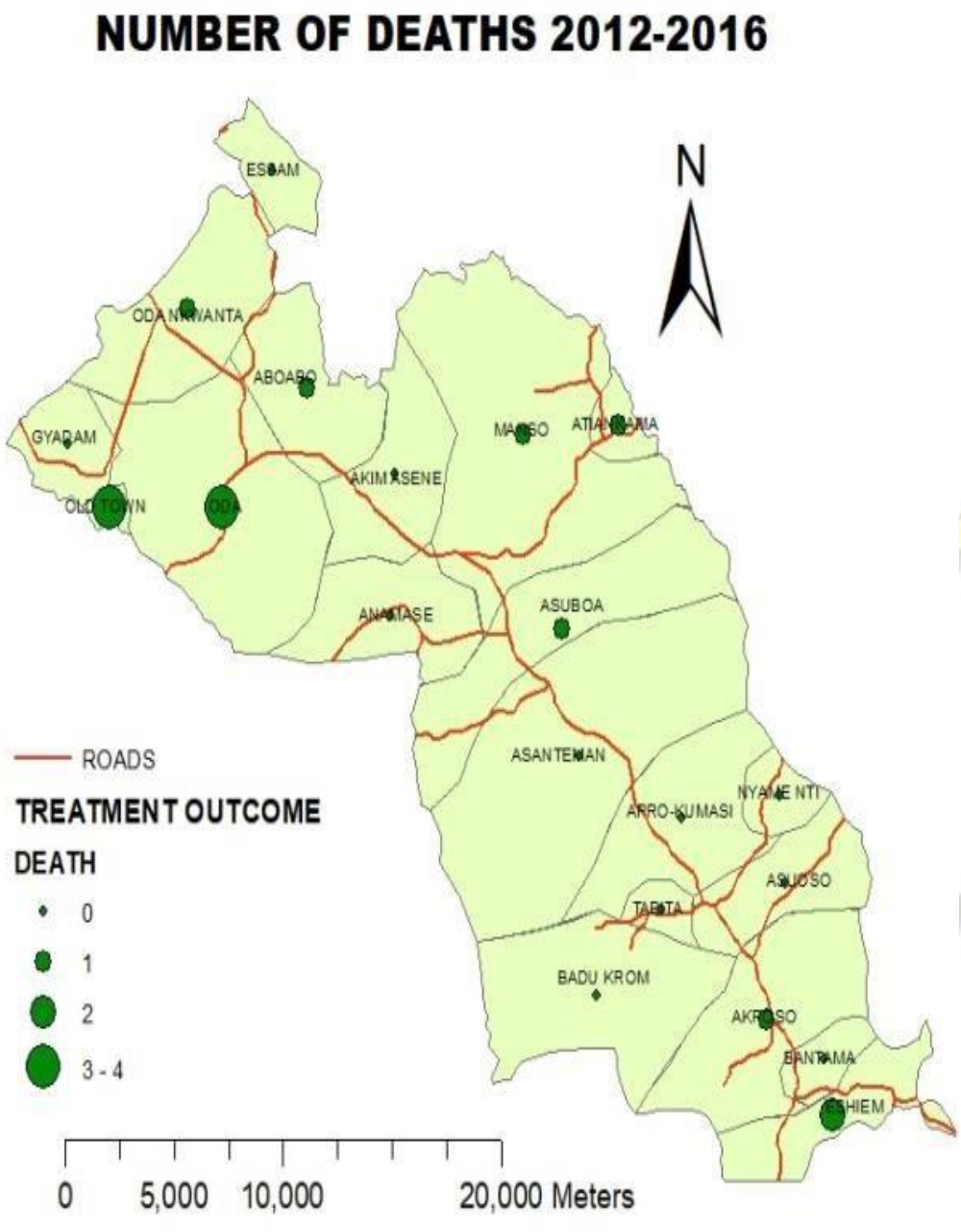


Figure 4.17: TB deaths distribution 2012-2016 Source: Field Survey

TB Treatment Failure 2012-2016, Birim Central

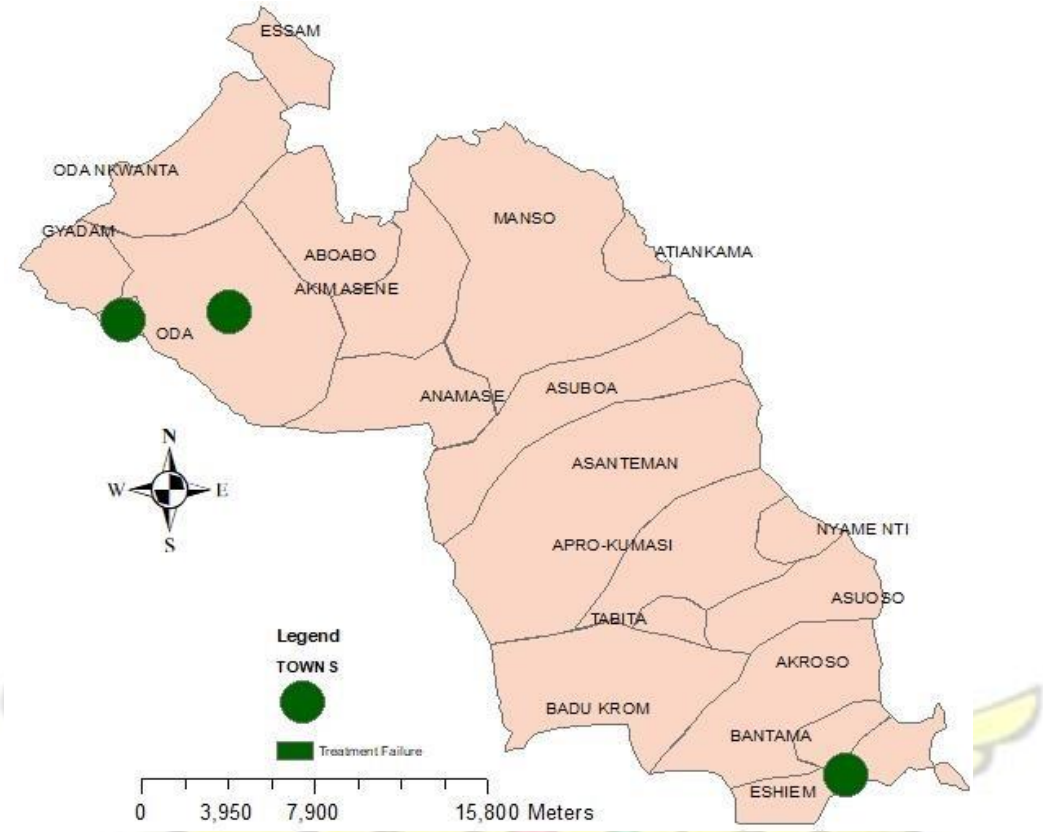


Figure 4.18: TB Treatment Failure 2012-2016, Birim Central

Source: Field Survey

The summary of the various treatment outcomes for the Birim Central municipality from 2012 to 2016 is presented in figure 4.19.

Treatment Outcomes from 2012 -2016, Birim Central Municipality

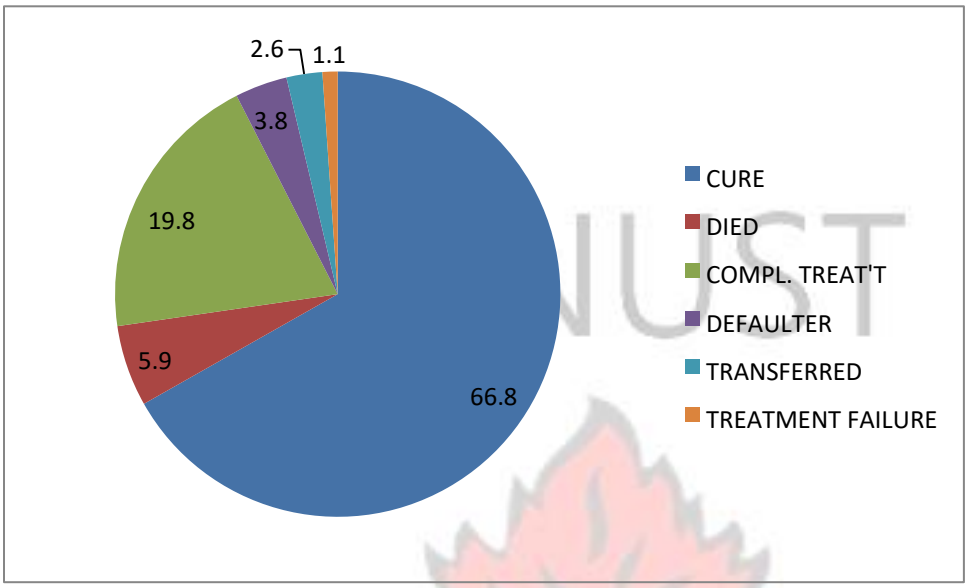


Figure 4.19: The five different treatment outcomes 2012-2016

Even though figure 4.19 illustrates successes in treatment outcomes, there are others such as died, defaulters, and treatment failure which need to be addressed.

4.5 Proximity of health facilities to patients' location and influence on TB treatment outcome:

How close or far a health facility is located to a patients‟ residence will likely impact the effectiveness of TB management within the municipality. To examine the issue of accessibility to healthcare, the study first looks at the health seeking behaviour and cost for TB patients. Patients were asked which facility they visited first when they began experiencing the cardinal sign of tuberculosis (coughing persistently). The results of this are presented in table 4.9.

Table 4.9: Patients first point of call when coughing persistently

Patients First point of call	N(%)
Drugs store	18 (40)
Herbalist	4 (9)
CHPS compound	19 (42)
Hospital	4 (9)
Total	45 (100)

Source: Field Survey

From the responses in table 4:5, majority of the patients visited the CHPS compound, as their first point of call, followed by the drug store. The health personnel confirmed the responses from the patients, five of the health personnel mentioned the Herbalist, one said the Traditionalist, seven mentioned chemical seller and three the health facilities.

Despite visiting various places upon the onset of the disease, the final diagnosis was done at a health facility. One patient was diagnosed at a health center and the remaining 44 patients at the district hospital. Majority of the patients (26) visited only one health facility before they were finally diagnosed of TB. Fifteen visited two health facilities and three visited four before finally diagnosed of TB. In an attempt to ascertain if patients initially accepted that they had TB when they were diagnosed, 31 said yes and 14 said no and of which out of the 14 who said no, 8 attributed it to witches/wizards, and 6 attributed it to curses.

The response confirms that of the health personnel which 13 of them said patients normally accept they have TB when they are told their diagnosis and only three said

no. The responses from patients when asked the cost of reaching the nearest TB care facility for diagnoses; the responses are given in figure 4:20.

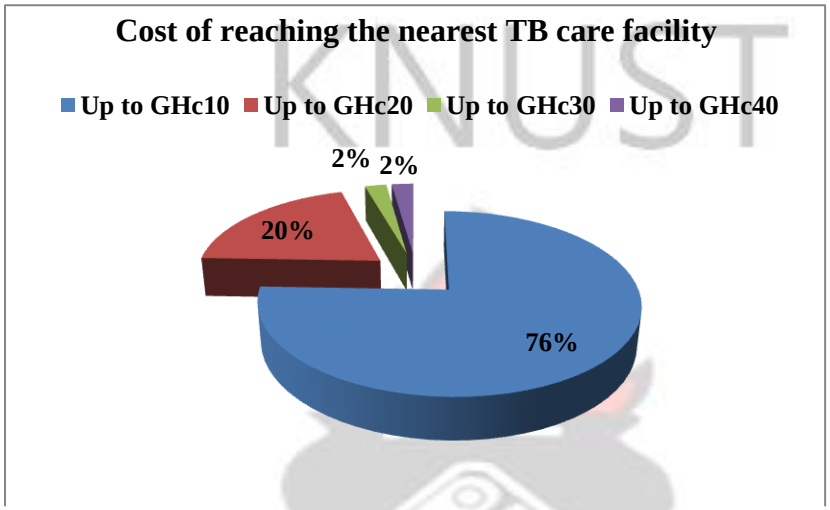


Figure 4:20 Source: Field Survey

From figure 4.20, 76% spend up to GHc10 before accessing a TB care center; 20% spend up to GHc20 and the remaining and few others said they spend up to GHc30 and GHc40 respectively before reaching the treatment center. It took 27 patients below an hour to reach the diagnosis site; 17 patients between 1 to 2 hours; and one patient 3 hours.

In trying to ascertain if health care providers were aware of how long it take their clients to reach health facilities for TB care, 12 of them estimated between 30 minutes to 1 hour and the remaining said between 1 to 2 hours thus confirming the responses from the patients. The patients were asked how often they collect TB drugs from the health facility and the results are presented in figure 4.21.

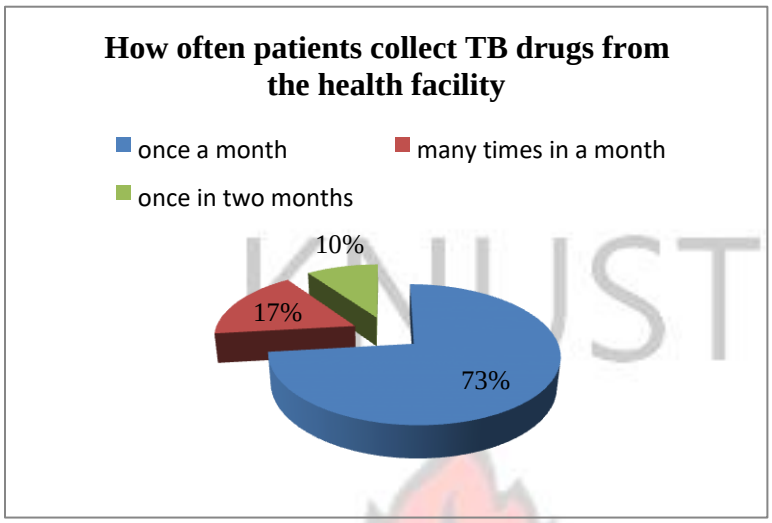


Figure 4:21
Source: Field Survey

From the figure 4.21, 73% (30) of the patients collect TB drugs only once a month, 17% (7) of them visits the nearest health facility many times in a month and 10% (4)visit only once in two months. Thirteen patients have to walk or travel long distance before assessing TB care. Only 6 of the patients were with the opinion that walking or travelling to TB care center affects their treatment compliance while majority (36) were of the view that whether they travel longer distances or not, it has no effect on their treatment compliance. On the contrary, patients stated that proximity of health facilities to their location influence the final treatment outcome as38 of the respondents stated that they don't have money to pay for vehicle fare, and one person said he/she feels lazy traveling to the hospital for review.

As distance is likely to be an impeding factor to the accessibility of TB patients to healthcare, an attempt was made to identify the spatial accessibility of health facilities dotted within the study area by estimating within a travel model, the

average travel time of TB patients that commute to health facility from their home. In order to evaluate the spatial accessibility to the health facilities from various parts of the study area, a network dataset had to be built using the road network of the Birim central municipality as presented in figure 4.22.

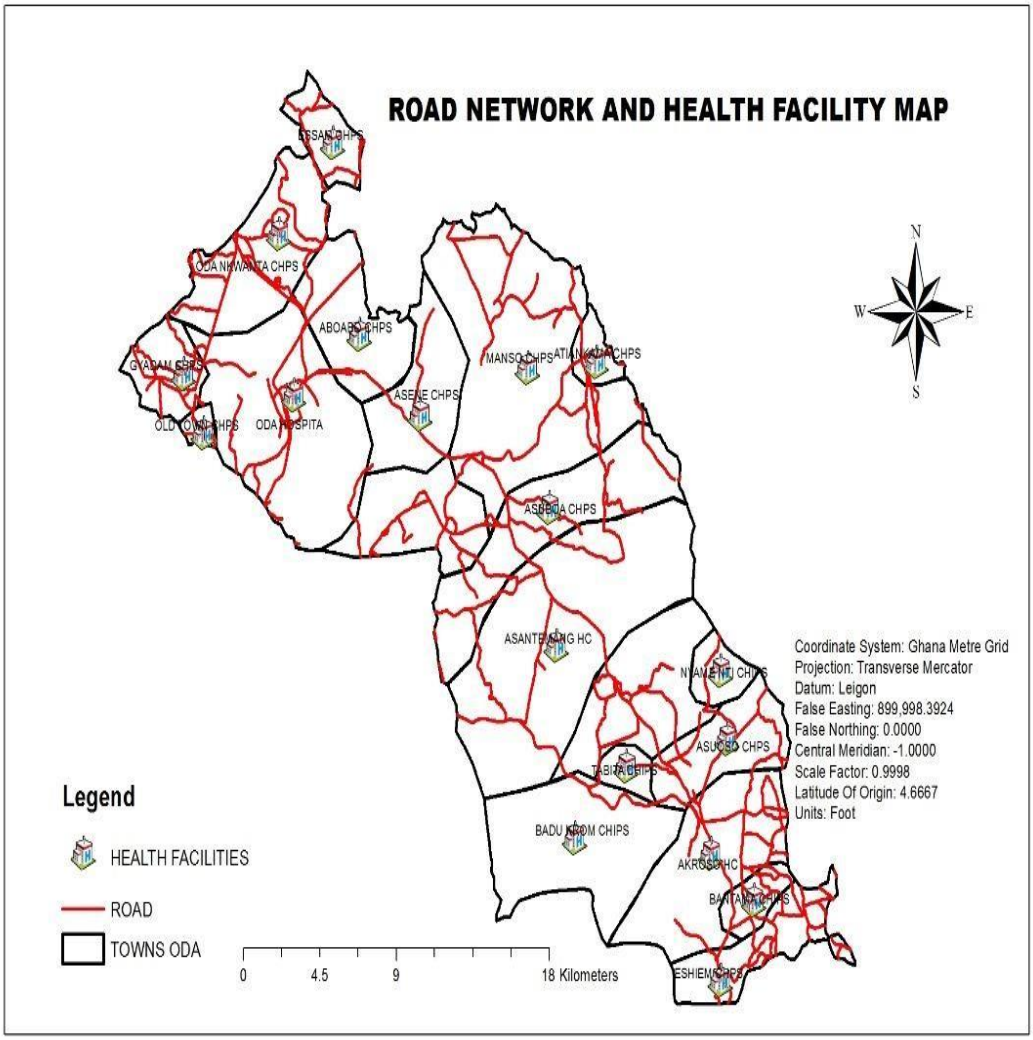


Figure 4.22: Road network Birim Central Municipality

Further, table 4.10 presents statistical inference on the location of health facility to TB patients‟ community and its effect on treatment.

Table 4.10: Correlations of location of health facility and TB treatment success

		Proximity to health facility affected my treatment outcome	I have seen improvement in my health condition	I visit the health facility regularly for treatment
Proximity to health facility affected my treatment outcome	Pearson Correlation	1	.007	.086
	Sig. (2tailed)		.966	.574
	Sum of squares and Cross products	13.111	.111	2.111
	Covariance	.298	.003	.048
	N	45	45	45
I have seen improvement in my health condition	Pearson Correlation	.007	1	.344*
	Sig. (2tailed)	.966		.021
	Sum of squares and Cross products	.111	21.911	10.911
	Covariance	.003	.498	.248
	N	45	45	45
I visit the health facility regularly for treatment	Pearson Correlation	.086	.344*	1
	Sig. (2tailed)	.574	.021	
	Sum of squares and Cross products	2.111	10.911	45.911
	Covariance	.048	.248	1.043
	N	45	45	45

*Correlation is significant at the 0.05 level (2-tailed)

4.6 Measures to improve the control of tuberculosis in the municipality

From the perspective of the patients, TB care can be improved in the municipality through the following means, as presented in table 4:6. Twenty percent of the patients said there should be more education, 17% said health personnel should conduct TB screening in communities regularly, 10% said treatment site should be closer to community, and 17% said financial assistance should be provided for patients. Fifteen percent said stigmatization of patients should be reduced.

Table 4.11: Improving TB care (TB patients)

How to improve TB care	N(%)
Do more education	42 (20)
Health workers should conduct TB screening in communities regularly	35(17)
Treatment site should be closer to community	21(10)
Provide more DOT points	21(10)
Provide financial assistance	37(17)
Reduce stigmatization	32(15)
Visit patients very often in their homes	24(11)

Source: Field survey

On the part of the health personnel, 16 said there should be regular screening in the community. But their responses on how often they conduct screening exercise for

community members on TB indicate that this is not done regularly. In the last two years, screening exercise for community members has never been done according to 7 of the health personnel. Their responses on how to improve the control of tuberculosis in the municipality is given in table 4:12.

Table 4.12: Improving TB care (Health Staff)

How to improve TB care	Response
Conduct regular screening in the community	16
Conduct massive education	15
Prevent stigmatization	10
Give financial support to TB patients	13
Counsel TB patients regularly	9
Get TB prevention ambassador	6
Motivate staff involve in TB care	12
Target specific populations for TB education	5
Present annual statistics on TB to different communities	6

Table 4:13 illustrates the level to which patients agree there could be better ways of improving TB control in the municipality

Table 4.13: New ways to help improve the control of TB

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation

Do you agree there are new ways to help improve the control of TB	45	3.00	2.00	5.00	162.00	3.6000	.98627
Valid N (list wise)	45						

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This final chapter provides a brief overview of the study, highlighting major findings to draw conclusions and to suggest a way forward. This chapter is categorized into three sections. The first section demonstrates how the original research questions and objectives set out in chapter one have been answered. The main findings and conclusions as well as hypothesis testing are next presented. This is followed by the next section, which covers recommendations for the study. The last section highlights new areas open for further research.

As already noted, the purpose of this study was to model cases of tuberculosis distribution and treatment outcomes using geographical information system - the case of Birim Central Municipality. Therefore, three objectives were set out and these were to:

- To ascertain the spatio-temporal distribution pattern of tuberculosis cases and treatment outcomes in the Birim Central Municipality from 2012 to 2016.
- To find out if proximity of health facilities to patients location have any influence on tuberculosis treatment outcome.

- To find out measures which can help improve the control of tuberculosis in the municipality

To achieve these objectives, a case study informed by survey was designed around the following three research questions:

1. What is the spatio-temporal distribution pattern of tuberculosis cases and treatment outcomes in the Birim Central Municipality from 2012 to 2016?
2. To what extent does proximity of health facilities to patients‟ location influence tuberculosis treatment outcome?
3. What measures can be put in place to improve the control of tuberculosis in the municipality?

5.2 Spatio-temporal Distribution of TB cases and Treatment Outcome

Per the NTP standards, it is expected that at least 200 cases of all forms of TB are recorded each year in the Birim central municipality with a population of over 170,000 people. With change in this standard by the NTP in year 2014, it can be said that there was an improvement in the case detection rate. However, it is possible that some non-spatial factors played a major role in failure to achieve yearly targets. Earlier studies (Dodor & Kelly, 2009; Storla et al, 2008) identified stigmatization as a main factor leading to low case detection.

Even though the targets were not achieved, TB is still considered one of the major diseases of public health importance in the municipality. The incidence of the disease has plateaued from a highest of 59 in 2012 and a lowest of 43 in 2014. This variation also reflects in the various communities within the municipality where

cases are identified. Figures 4.3 to 4.9 which illustrate the spatial distribution of cases clearly indicate the hot spots of the disease in Oda, Oda Old town, Asene, Atiankama, and Akroso. This is possible because these communities have relatively larger populations in the municipality. To confirm this, the cases identified in the various communities were compared to their respective populations. Table 4.5 shows that the prevalence of TB for the five year retrospective period is high in Aprokumase, Oda Old Town, Akroso, Aboabo,

Asene, and Eshiem. The prevalence in Akim Oda seems to be relatively low. However, in a highly populated area such as Akim Oda township where there are slums and possibility of overcrowding, even few cases of TB can spread very fast than in communities with fewer populations. A prevalence of 1.5/1000 population is wealth considering as focal area for TB spread.

An attempt was made to establish if there is any spatial relationship between these hot spots of TB and the kind of treatment outcome recorded (figures 4.10 to 4.19). A very large portion of the cases had positive treatment outcome which are treatment completed (19.8%) and cured (66.8%) (Figure 4.11). These treatment successes match that of the national successes in TB treatment (table 2.1) and thereby giving an indication that the municipality is on track in TB control. In this current study, a higher number of treatment successes are located in Akroso, Oda, Asene, and Atiankama. However, the rate of adverse outcomes such as death, defaulters, and treatment failure need to be looked at critically in these areas.

Though the adverse treatment outcomes do not vary much from the national status

(table 2.1), it is still not very good for the TB control program in the municipality. In spite of the proximity of health facilities to patients in Akim Oda and Oda Old town, these communities recorded the highest number of treatment failures, and deaths. Treatment defaulters were highest in Akim Oda and Atiankama and this is not good for the control program. Comparing the populations in the various communities, the treatment failure per 100,000 populations is very high in Eshiem community (table 4.8) than in any other community. Similarly, Aprokumase, Atiankama, and Eshiem recorded the higher defaulter rate per 100,000 populations. The findings in this study which are likely contributory factors to increase in adverse outcomes include long travel time to the only sputum examination center at Akim Oda (Oda Government hospital) and superstitions. This finding supports that of Muture et al (2011) who also gave similar reasons for TB patients defaulting and failing in treatment. Bronner et al (2012) suggest prompt following up of patients who miss treatment and sputum examination appointment dates. More to this, a conclusion from an earlier study (DiefenbachElstobet et al, 2017) points that education is one sure way of improving treatment adherence and successes in outcomes.

5.3 Proximity of Patients to Health Facility

How close or far a health facility is located from a patient is an important factor in determining whether patients will visit these facilities in order to get them managed or not. It is evident from table 4.9 that patients will visit health facilities that are easily accessible and are close to them as most of the TB patients for the first time

visited the CHPS compounds located in their localities when they exhibited the cardinal sign of TB. In terms of accessibility to TB care centers and diagnostic points, most of the patients travel longer distances but said this never affected their complying with the drug intake initially. It however has effect on the final treatment outcome as travelling longer distances to diagnostic centers for review of their sputum have effect on their finances. Several studies have highlighted the impact of longer distances of patient location to health facilities (Tadesse et al, 2013) and how it negatively affects treatment processes. In this particular study, TB patients spend about GHc10 which is approximately USD 2 (76%), to as high as GHc40 (20%) which is almost USD 8 as the cost of accessing diagnostic facilities. This could be the reason for patients visit to herbalists, drugs stores, and CHPS compounds which are located close to them. An earlier study by Li et al (2016) also attributes poor treatment outcomes to clients staying far away from treatment centers. Again, travelling longer distances to sputum examination centers will have impact on the finances of the patient. Even though, all the patients have some source of income with few unemployed (11%), persons with TB cannot be very productive as they are sick and this will have impact on their finances. An earlier study therefore recommended the inclusion of all peripheral facilities in the TB control program (Taser & Wilkinson, 1999) which is the case in the study area of this particular study. Muture et al (2011) explained that longer traveling time to treatment centers contributes to defaulting in treatment. As explained by Muture et al (2011), access to herbal preparation as in the case of this current study, contributes to treatment failure. However, Diefenbach-Elsobet et al (2017) does not relate poor treatment outcomes to location of clients with respect to where a health

facility is located but rather attributes treatment failures to social factors such as witchcraft and curses which are some of the things some

TB patients in this study attributed their suffering to. This prevents patients from accepting fully the cause of their disease and thus has consequential effect on their treatment. Again, an earlier study by Said et al (2017) does not agree perfectly that distance is a main factor for late reporting of cases and treatment success. Said et al (2017) attributed poor treatment outcomes and late reporting to self-prescribed medicines. A sizeable number of the respondents in this study resorted to drugs store for medications thereby supporting the conclusions from Said et al (2017).

For further analysis of the patients‟ location vis-à-vis health facility location whether it has any relationship with outcome of treatment, road network map was developed (figures 4.22). The road network gives a clearer picture of the location of health facilities in the communities where cases are coming from. All TB treatments are supervised by the health staffs in the various health facilities located in the community where these patients come from (figure 4.2). Table 4.4 indicates that most of the health staff involve in TB care play the role of patient treatment and follow up. This suggest that there should be little problem with supportive care given to these patients and therefore, negative treatment outcome should be relatively lower than recorded. It therefore sounds logical to say that patients‟ proximity to health facility should not have any effect on treatment outcome for this current study. However, not all patients live close to where these facilities are located because some of the patients live in isolated hamlets but are still served by the nearby health facility. Still, in the urban centers, some patients live far away

from the location of the health facility. Again, because not all of these health facilities provide diagnostic services, patients would have to travel to the only hospital in the municipal capital for sputum monitoring. Traveling to the only diagnostic center has effect on the finances of the TB patient (figure 4.20) hence most of them will not show up for sputum monitoring and this leads to negative consequences on the patient management. Table 4.6 shows that there is a significant positive correlation between the location of health facility and TB patient‟s treatment success. But one fact remains: some of the patients believe their illness is as a result of bewitching or curse (31%). This proportion is relatively small but need to be addressed well as failure to do this may lead to poor treatment outcomes. Even though table 4.9 indicated that a relatively small percentage (9%) visited the herbalist as a first point of call when they had features resembling Tb, failure to address this notion that Tb is cause by witches and curse may influence others in the communities and will not report on time for early management. However, a further research should adopt a qualitative approach to ascertain the main causes of negative treatment outcomes in the municipality.

5.4 Improving Tuberculosis Care

The national TB control program has for many years looked for several ways of improving the program. From the study, both service providers and TB patients recommend education as one of the best ways of improving upon the program. An earlier study (Jurcev-Savicevic et al, 2013) concluded that low level of education

and poverty play major role in the progress of TB program. Considering this current study, majority of the respondents, 33.3% and 42.2% (table 4.3) respectively had no formal education and only up to Junior High School. Educating this large population who hitherto may not be exposed to lots of information on diseases including TB is a crucial step in controlling the disease. For the fact that majority of the patients and health staff stated that education is a key way of controlling the disease agrees with an earlier findings (Kassirer, 2010; Kigozi et al, 2017) that community members need to be educated on the clinical features and provide accurate information that empowers the patients to take action to restore their health.

Another important way of controlling TB disease suggested by both health staff and patients is to work strongly to reduce stigmatization. One way to do this is to direct education on the misconceptions about the disease (Deribew et al., 2010). Similarly, an earlier finding (Moller et al., 2011) supports this and concludes that reducing stigmatization will encourage suspected individuals to report as early as possible. Another important issue raised by patients was that health staffs should visit them often in their homes. This gives an indication that when several home visits are made to clients, issues with poor treatment outcomes will be controlled and this actually agrees with the recommendation by Kolifarhood et al., (2015) and Bronner et al., (2012). Similar to this, patients and health staff were of the view that conducting regular screening in the communities will help identify cases early and to manage them to prevent further spread. However, this screening exercise is not

done in the study area. Regular screening of the suspected individuals both at the health facility when they present with cough and also in the community on outreach basis will help detect more cases promptly and to treat them to halt further spread. A study suggested that (Huong et al, 2007) health staffs in both public and private institutions need to be sensitized. This is a key area in public health surveillance. In the study area abound a number of public and private health facilities. Staff of these facilities needs to be sensitized at least twice in a year on the disease so that more cases can be suspected and diagnosed.

It was also found that when the municipality gets a prevention ambassador such as a formerly cured TB patient, the individual will greatly help in the control of the disease. Clearly if these measures are embarked upon by the municipality, much of the problem with TB will be controlled.

5.5 Hypothesis Testing and Conclusions

The following are the conclusions from the study:

From the spatial and temporal distribution of TB cases, the null hypothesis (**Ho1**) is rejected. There are significant differences in the temporal distribution pattern of tuberculosis cases in the Birim Central Municipality from 2012 to 2016 (p- value =0.001). The TB hotspots in the Birim Central municipality are Akim Oda, Oda Old town, and Akroso. Treatment success rate in the municipality is high but adverse outcomes in some communities are high. There are no differences in the

spatio-temporal distribution of TB cases and treatment outcomes in the municipality from 2012 to 2016.

Again, there is significant relationship between the location of health facility and TB treatment success and therefore, the null hypothesis is rejected (*p-value* = 0.007). An analysis of the variables used to measure the correlation between health facility and treatment outcomes is shown in table 4:10. However, the cause of adverse treatment outcomes in the study area can not only be attributed to how distant a health facility is located from the patients‟ community but also as a result of non-spatial factors such as financial constraints and myths about the disease.

Lastly, there are new measures to adopt to ensure improvement in the TB control program (mean of 3.6). The null hypothesis is rejected. The measures for control include regular sensitization of service providers, regular screening in the communities, intensive education, and training a formerly cured TB patient as a peer educator. The null hypothesis is therefore rejected.

5.6 Recommendations

The following recommendations are made from the study:

5.6.1 The Birim Central Municipal Health Directorate

1. Intensive mass education is highly recommended in hotspot communities and should be conducted at least twice in a year. Patients declared cured in the past should be trained so they become key members in the education

team. Education in the communities must also focus on demystifying myths on TB. This will help reduce stigmatization.

2. There should be intensive case search of cases in the communities coupled with contact tracing
3. Screening activities at all health facilities should be taken seriously in order to detect and manage more cases.
4. In order to reduce adverse treatments such as defaulters, a trained formerly cured TB patient can be assigned to regularly visit and encourage patients who live close to them. This will significantly reduce defaulting and treatment failures.
5. Sputum of patients for monitoring purposes can be collected from them in their homes in order to reduce financial challenges faced by patients in accessing health facilities.
6. Service providers should be sensitized on regular basis in order to appreciate the program and be more involved in TB activities. Capacities of Community Health Officers (CHOs) at the various CHPS compounds must be strengthened since this is one of the focal points of patients visit when they are sick. Herbalist as well as chemical sellers should be sensitized on TB in order to suspect and refer cases to the hospitals for diagnoses.

5.6.2 Communities

Community members must report cases as early as possible when they start coughing. Opinion leaders such as chiefs and his elders, unit committee members

and the Assembly man need to be actively involved in disease surveillance activities including surveillance on TB.

5.7 Limitations

While a study such as this demonstrates the usefulness of GIS, there are some limitations. The study‟s conclusions were made on TB cases seen during the period of 2012 to 2016 in the Birim Central Municipality only. This number of cases represents only the tip of TB cases recorded for the same period in the entire Eastern region. Again, different populations behave differently to disease management processes. These issues place restrictions on generalizing the findings of the study.

5.8 Suggestion for Further Studies

A detail study, preferably a mixed method of quantitative and qualitative approach should be used to investigate the actual causes of adverse treatment outcomes in the municipality.

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APPENDIX A: QUESTIONNAIRE FOR HEALTH STAFF

Section A: Background of Respondents

1. Type of Health institution where you provide TB care
   a. Hospital ( )
   b. Health center ( )
   c. CHPS compound ( )
2. What is your role in TB care in the municipality?(Tick as many that apply to you)
   a. Municipal TB Coordinator ( )
   b. Institutional TB Coordinator ( )
   c. Diagnostic services only ( )
   d. Patient records management ( )
   e. Patient Treatment only ( )
   f. Follow up ( )
   g. Other (specify)……

Section B: Health Seeking Behaviour of TB Patients and Cost

3. Which facilities do patients normally seek health care first when they have suspected TB?
   a. Herbalist ( )
   b. Traditionalist ( )
   c. Chemical seller ( )
   d. Quacks ( )

e. Health facilities ( )

f. Other

(specify)…….

4. How long do patients normally travel before they seek TB care?

a. Below 30 minutes ( )

b. 30 min to 1 hour ( )

c. Between 1 to 2 hours ( )

d. Above 2 hours ( )

5. Do patients normally accept they have TB when they are told their diagnosis?

a. Yes ( )

b. No ( )

6. How often have you conducted screening exercise for community members on Tuberculosis during the last two years?

a. Only once

b. Twice

c. Thrice and above

d. Never

7. Is it possible for service providers to visit TB patients to collect sputum samples during patients review periods?

a. Yes ( )

b. No ( )

Section B: Improvement in TB Care

8. Which of the following should be done to improve TB care in the municipality of Birim Central? (select as many)

   a. Conduct regular screening in the community ( )
   b. Conduct massive education ( )
   c. Prevent stigmatization against persons with TB ( )
   d. Give financial support to TB patients ( )
   e. Counsel TB patients regularly ( )
   f. Get TB prevention ambassador ( )
   g. Motivate staff involve in TB care ( )
   h. Target specific populations for TB education ( )
   i. Present annual statistics on TB to different communities ( )
   j. Others (specify)…….

APPENDIX B: QUESTIONNAIRE FOR PATIENTS

Section A: Background of Respondent

1. Please indicate your sex
    a. Male ( )
    b. Female ( )
2. Please what is your marital status?
    a. Married ( )
    b. Single ( )
    c. Widow ( )
3. Please what is your age in years?
    a. Up to 20 ( )
    b. 21 - 40 ( )
    c. Above 40 ( )
4. Please tell me your occupation
    a. Unemployed ( )
    b. Student ( )
    c. Farmer ( )
    d. Civil servant ( )
    e. Trader ( )
    f. Others (specify)……
5. Please what is your highest level of educational?
    a. No formal education ( )
    b. Up to Junior High ( )
    c. Senior High ( )

d. Tertiary ( )

Section B: Health Seeking Behaviour and Cost for TB Clients

6. Which facility did you visit first when you started coughing persistently?
   a. Drugs store ( )
   b. Herbalist ( )
   c. CHPS compound ( )
   d. Hospital ( )
7. Where were you finally diagnosed of Tuberculosis?
   a. Health center ( )
   b. District Hospital ( )
   c. Regional Hospital ( )
8. How many different facilities did you visit before you were finally diagnosed of TB?
   a. Only one
   b. Two
   c. Three
   d. Four and above
9. Did you accept initially that you had TB?
   a. Yes ( )
   b. No ( )
10. If you did not accept initially, what did you believed caused your suffering?
    a. Witches /wizards ( )

b. Curse ( )

c. Punishment from God ( )

d. Other

(specify)……

11. How much vehicle fare did you pay before reaching the nearest TB care facility for diagnoses?

a. Up to GHc10

b. Up to GHc20

c. Up to GHc 30

d. Up to GHc 40

e. Other (specify)…….

12. How long did it take you to reach the diagnostic site?

a. Below 1 hour

b. 1 to 2 hours

c. 3 hours

d. Other (specify)……..

13. How long does it take you to reach the TB care center for drugs?

a. Below 30 minutes ( )

b. 30 minutes to 1 hour ( )

c. Between 1 – 2 hours ( )

d. Above 2 hours ( )

14. How often do you collect TB drugs from the health facility?

a. Once a month ( )

b. Many times in a month ( )

c. Once in two months ( )

d. Other (specify)……..

15. Do you walk or travel long distance before assessing TB care?

a. Yes ( )

b. No ( )

16. Does walking or travelling to TB care center affect your treatment compliance in any way?

a. Yes ( )

b. No ( )

c. May be ( )

17. How does proximity of health facilities to patients‟ location influence tuberculosis treatment outcome?

a. I feel lazy travelling to the hospital for review ( )

b. I don‟t have money to pay for vehicle fare ( )

c. Other (specify)……..

18. How can we improve upon TB care in the municipality? (choose as many)

a. Do more education ( )

b. Health staff should conduct TB screening in communities regularly ( )

c. Treatment site should be closer to community ( )

d. Provide more DOT points ( )

e. Provide financial assistance ( )

f. Reduce stigmatization ( )

g. Visit patients very often in their homes ( )

h. Others (specify)…….……

APPENDIX C: CONSENT FORM

Dear Sir/Madam,

The researcher is a final year student of the Kwame Nkrumah University of Science and Technology, Kumasi specifically studying Health Informatics in the Computer Science Department. The research is about modeling tuberculosis distribution and treatment outcomes using geographic information system in the Birim Central Municipality. You have been scientifically selected to participate in this study. Your views and opinions are therefore crucial to the success of the study. I should therefore be very grateful if you will spare about 10 minutes of your time to respond to the questions provided you. Be assured that this exercise is just for academic purpose and that all information provided will be treated very confidentially. Even though you may not benefit directly, the results of this study will help shape the control of TB in the Birim Central Municipality (BCM). Be assured that there would be no harm caused you for taking part in this study. You have every right to stop answering the questions at any point in time with no related punishment. If you want further clarifications, you can contact the following numbers:

Boaz Ahulu (Researcher) – 0205214000 / 0244966013 Frimpong

Twum (PhD) (Supervisor) – 050 134 8808

Thank you

APPENDIX D

In case of reply
the date of this letter
Should be quoted

My Ref ...BCM/MHD/INTL/I8/02/08

Your Ref.....

GHANA HEALTH SERVICE
Your Health - Our Concern

Ghana Health Service
Birim Central Municipal
Health Directorate
P. O. Box 429
Akim Oda

8th February, 2018

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

APPROVAL TO CONDUCT RESEARCH IN BIRIM CENTRAL
MR. BOAZ AHULU

Approval is given to you to conduct research in Birim Central on the topic: Modeling Tuberculosis Distribution and Treatment outcomes using geographical information system, the case of Birim Central Municipal, Eastern Region, Ghana.

Kindly give him all the necessary assistance to conduct this research successful.

Thank you.

Ms. Anastasis Atiogbe
Municipal Director of Health Services

Signature or initials of respondent……