NOMADIC PASTORALISM AND THE PREVALENCE OF PULMONARY TUBERCULOSIS (TB) IN THE NORTH-WESTERN REGION OF NIGERIA

BY

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UNIVERSITY OF IBADAN

ABSTRACT

The pattern of human mobility affects the spread of infectious diseases, particularly tuberculosis (TB), the transmission which is associated with several factors, including the consumption of unpasteurised milk. However, the very few studies that have been conducted on the role of seasonal migration on disease transmission are inconclusive. In particular, the transmission of TB along seasonal migration routes in Nigeria has not been given adequate attention. This study, therefore, examined the prevalence of pulmonary TB in the North-western region of Nigeria.

Using a survey design, disease ecology and distance decay effect provided the framework. Purposive and random sampling techniques were used to collect data from the records of 15 Directly Observed Therapy Short-course (DOTS) each along and off-route centres. A structured questionnaire was administered to 461 (26.6%) proportionately and randomly selected patients receiving treatment. Data were collected on the socio-demographic (gender, age, marital status, population size, work history, occupation type, income and literacy levels), behavioural (visits to health centre to treat TB, smoking, consumption of unpasteurised milk profiles and perceived causes of TB), and environmental (history of infection with TB, access to healthcare and exposure to dust) factors. Data were also collected on distance (determined from topographical maps) along and off-route TB centres, duration of stay in a place and number of health facilities. Population figures were projected from 1991 population census results to 2010. Student's t-test, Simple Linear Regression, Correlation and Analysis of Variance were used for data analyses at $p \leq 0.05$.

Sixty-five percent of the respondents were male and 161 (34.9%) female respondents; 29.0% had a job while 39.3% had no formal education, 35.0% had visited clinics to treat TB, 35.0% consumed unpasteurized milk and 28.0% smoked cigarettes. Infection (35.1%), dust (14.1%), smoking (12.1%), spiritual attacks (10.4%), drinking of cold water (10.0%) and unpasteurized milk (1.5%) were the perceived causes of TB. Whereas, 47.7% had TB, 39.2% were exposed to dust, 9.2% family members were infected, 6.4% had lung diseases and 8.5% stayed with infected persons. Cost (45.3%), attitude of health personnel (13.4%), time (13.0%) and distance (9.7%) were the determinants of access to healthcare. Gender (t=2.1), marital status (t=4.0), work experience (t=2.8) and work type (t=-3.2) were significant in TB prevalence. Lung diseases (β=4.9), spiritual attack (β=4.3), farming (β=4.0) and distance to healthcare centres (β=3.7) positively contributed to TB prevalence while distance along (r=-0.17) and off-route (r=0.11), and duration of stay did not. Similarly, TB prevalence had a strong positive relationship with population size (r=0.76) and number of health facilities (r=0.87). Month of the year affected TB prevalence among off-route centres [$F(26,153)=2.06$], whereas income [$F(17,57)=5.40$], literacy [$F(20,24)=5.15$] levels, and work duration [$F(11,48)=2.77$] affected prevalence along the route. Tuberculosis was more prevalent during the dry season (November-April**)** and reduced southwards.

Human mobility did not substantially affect tuberculosis prevalence in North-western region of Nigeria. However, continuous monitoring and control of the disease within the region is required.

Keywords: Nomadic pastoralism, Pulmonary tuberculosis prevalence, Disease ecology, Distance decay effect, North-western Nigeria.

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1

UNIVERSITY OF IBADAN

DEDICATION

I wish to dedicate this piece of work to my parents:

My father, the most humble and generous gentle man I have ever known. How I wish you are here to share the joy with me.

My mother, the most loving and caring I have ever known. Your ability to love and give encouragement is remarkable and inspiring.

Thank you, for I cannot pay for what you have done for me.

UNIVERSITY OF IBADAN

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UNIVERSITY OF IBADAN

TABLE OF CONTENTS

Contents **Page**

UNIVERSITY OF IBADAN

UNIVERSITY OF IBADAN

UNIVERSITY OF IBADAN

List of Tables

UNIVERSITY OF IBADAN

UNIVERSITY OF IBADAN

List of Plates

UNIVERSITY OF IBADAN

List of Figures

UNIVERSITY OF IBADAN

CHAPTER ONE

BACKGROUND TO THE STUDY

1.1 Introduction

Within the last two decades, communicable diseases have shown an unprecedented and rather unexpected rise in infectivity despite the strides made in immunization, provision of heath care facilities and services, discovery of drugs and better understanding of the nature of many of these diseases. For a long time, population mobility has also served as an agent for their spread (Carballo 2007a). Examples include the spread of measles and smallpox during the colonization of the Americas by the Europeans in the 15th century, the human influenza epidemic in the 20th century, the global spread of HIV/AIDS from the early 1980s onward, the SARS outbreak in late 2002, the avian influenza outbreak of 2003 (Weitz, 2007), the swine flu (H1N1 Influenza) and more recently, the Ebola fever pandemic in West Afica. When AIDS became first known for instance, cases were traceable to mobile individuals or groups, such as truck drivers, military personnel or returning migrant workers. Thus, the pattern of mobility (and frequency of contacts) seems to affect transmission of contagious diseases or the exposure of people to them. This study is concerned about Pulmonary Tuberculosis (TB), which is one of these infectious diseases that are on the rise partly as a function of population mobility.

Tuberculosis (TB) is caused by the pathogens, *Mycobacterium tuberculosis* (in humans) and *Mycobacterium bovis* (in animals), and spread through droplets of sputum or particles of dust, which are inhaled into the lungs. Pulmonary tuberculosis simply refers to tuberculosis of the lungs or infection of the respiratory tract, as opposed to extra-pulmonary tuberculosis which is that of the joints. Iseman (1994) believes that at some point in undetermined history, *Mycobacterium bovis* underwent adaptation to spread from animals to humans and became the causative agent of tuberculosis in humans. However, Smit (2005) simply links the transmission of tuberculosis to historical patterns of human migration as evidenced by a remarkable ability of the disease agent to exist in the human host as a latent asymptomatic form for more than four months as rightly observed by Mitsos *et al*. (2003) that only a

UNIVERSITY OF IBADAN

small proportion of individuals infected with *M. tuberculosis* develop the clinical form of TB. Earlier on, Saunder, (2001) had reported the findings of one epidemiological report which estimated one-third of the sub-Saharan Africa carrying the latent form of *M. tuberculosis* infection which might have increased the pool of the HIV- pulmonary TB co-infection in the region. As an infectious disease, TB has social, biological and environmental characteristics which lend it for geographic study. This is even more so now that there is an increased risk from the disease as a result of HIV infection to which it is linked opportunistically, as well as the global emergence of multi-drug-resistant strains of tuberculosis (MDR-TB), which further compounds the problem.

The World Health Organization (WHO, 2006) ranked Nigeria as the world's 4th largest country with tuberculosis cases in 2004, with nearly 374,000 estimated new cases annually. In 2008, this position dropped to the 5th, with South Africa becoming the 4th. WHO put 75% of the new TB cases in Nigeria as pulmonary sputum smear-positive (SS+), with the total notified cases of all forms having increased from 46,473 in 2003 to 59,493 in 2004. At the end of 2005, 66,848 cases of TB had been reported and documented, of which only 52% were SS+. Again, WHO estimates that 27% of Nigeria's TB patients are HIV-positive which, even though not our main concern, gives an insight on the dangers of increasing TB cases in the country since the two diseases are opportunistically related. According to the United States Embassy in Nigeria (2012), there were an estimated 320,000 prevalent cases of TB in 2010 and the age groups commonly affected were the most productive age groups, with the 25 – 34 age group accounting for 33.6% (15,303) of the smear positive cases registered in the year.

It has been observed by a number of scholars that one of the major health problems among nomadic people is tuberculosis. This observation was made among the Sahelian nomads (Chabasse *et al*, 1985) and nomadic or seminomadic populations in Kenya (van Cleeff *et al.* 1995). Sheik-Mohammed *et al* (1999:698) have also noted the high prevalence of tuberculosis among nomads, attributed to 'poor health care infrastructure in the areas where nomads live and poor compliance related to the mobile lifestyle of patients that allow the infection to spread'. Abubakar *et al*. (2005) have shown a high prevalence of both bovine and human tuberculosis amongst

UNIVERSITY OF IBADAN

herders in Abuja, the Federal Capital, which can be explained by the communal lifestyle of the Fulani nomads because of their close proximity with their livestock as well as certain cultural practices (Akinbowale, 2008; p.29). The Fulani are one such group of nomadic pastoralists, who move daily and migrate seasonally with their herds and the household (or in a semi-nomadic lifestyle alternating between a settled household and a temporary residence) to manage uncertainty and risk in arid and semiarid ecosystems of Africa. Their main diet is reported to be unpasteurized milk or its by-products, though cereals appear to be their staple food (Sharubutu 2007, Mawak *et al* 2006, Ayele *et al,* 2004 and McGeary 2008). They are also constantly in the midst of their animals and hand-milking of cows is common among them. Even though the population size of nomadic Fulani pastoralists in Nigeria may be small (not properly ascertained because of their mobile nature) compared with other ethnic groups, their life course may be relevant in affecting the distribution of tuberculosis. Given their geographic isolation/remoteness from services and poor communications, it was thought necessary to understand the risks that they and their animals pose to the larger society in disease transmission. The following questions therefore arose:

- ✓ Do the nomadic Fulani and their animals in any way serve as carriers and help in the spread of tuberculosis during the course of seasonal movements within the region?
- ✓ Does the availability of unpasteurized milk or its by-products at the stop-over and destination points have any effect on the prevalence of tuberculosis in the Region?

The research therefore attempted to answer these questions.

1.2 Statement of research problem and the scope of the study

Given the possibility of zoonotic tuberculosis infection between the Fulani and their stock through consumption of unpasteurized milk or its by-products (Alhaji *et al,*1977; Idigbe *et al*, 1986; Daborn *et al*, 1996; Cosvi *et al,* 1998; Ishola *et al*, 2001; Schelling *et al* 2003, Mawak *et al* 2006;Ayele *et al* 2004; Toen *et al,* 2006; Davies 2006; Cadmus *et al,* 2006; Yumel *et al,* 2007; Beals, 2007; Sharubutu, 2007; Ofukwu *et al,* 2008; McGeary 2008; HPA 2009 and Abubakar *et al,* 2011) and their proximity to the livestock, hand milking, as well as the dust raised by the animals, it is logical to assume that the Fulani and their animals could serve as potential carriers

UNIVERSITY OF IBADAN

and their movement could facilitate the spread of tuberculosis. This proposition was informed by the Fulani's insufficient access to health care due to their mobile lifestyle and the possibility of developing resistant strains due to abscondment during travels. Similarly, the availability and consumption of unpasteurized milk and its by-products in the stop-over and destination areas could be influenced by the pattern of seasonal migration, which may in turn affect the prevalence of bovine tuberculosis through zoonoses in such areas. Therefore, given these scenarios and the epidemiology and aetiology of tuberculosis, this study explored the factors at play in the spread of tuberculosis during seasonal movements of nomadic Fulani pastoralists and their livestock in the Northwest Region of Nigeria in an attempt to explain associations between the prevalence of tuberculosis and human mobility.

1.3 Aim and objectives of the study

This study examined the interrelationships between mobility as a vehicle in disease transmission and the prevalence of tuberculosis in the areas of origin, stop-over and destination within the Northwest region of Nigeria with the following objectives:

1) Identify the migration routes and the origin, stop-over and destination settlements of nomadic Fulani;
2) Identify the pattern of migration of the Fulani nomads
3) Determine the spatial and temporal patterns of TB prevalence;
4) Examine the relationship between seasonal migration pattern of the Fulani and the prevalence of tuberculosis;
5) Determine the environmental and behavioural risk factors in the prevalence of the disease; and
6) Examine the demographic and socio-economic correlates of the disease in the region.

1.4 Working hypotheses

To achieve the objectives of the study, the following questions were raised:

i) What is the pattern of TB prevalence in the study area?

UNIVERSITY OF IBADAN

ii) Does the duration of stay of nomadic Fulani at stop-over settlements have any relationship with the prevalence of tuberculosis in that area?

iii) What is the nature of relationship between gender and age of patients in the prevalence of tuberculosis within the region?

iv) What environmental and behavioural risk factors contribute to the prevalence of tuberculosis in the region?

To answer these questions, the following hypotheses were formulated to guide the research process:

i) There is a positive relationship between duration of stay of nomadic Fulani in a settlement and the prevalence of tuberculosis;

ii) Distance from the origin of migration and away from the route plays a significant role in determining the prevalence of tuberculosis in the Region;

iii) Males and Children are more prone to tuberculosis infection than females and adults respectively;

iv) Environmental risk factors play significant roles in determining the prevalence of tuberculosis;

v) Socio-economic correlates such as work history, occupation, income, literacy level, access to health care and perception, affect the prevalence of TB in the region; and

vi) The higher the population size of settlements the higher the prevalence of tuberculosis in the study area

1.5 Definition of terms

In a study of this kind, it is pertinent to define operational terms peculiar to the field for easy understanding of the subject matter. These definitions are given as follows:

- ***Pastoralism*** is here defined as a means of livelihood based on livestock raising, and can be undertaken by sedentary or mobile communities.
- ***Nomadism*** is the spatial movement of people for specific activities such as fishing, herding, hunting, etc.

UNIVERSITY OF IBADAN

- ***Nomadic pastoralism*** connotes seasonal mobility of pastoralists with their livestock aimed at managing uncertainty and risk such as drought, diseases, raids and insect vectors in arid and semi-arid ecosystems.
- ***Susuceptibles*** are those people likely to get infected with a disease
- ***Infectives*** or ***infecteds*** are those already with the disease.
- An ***infectious*** person is one who is actively able to pass the disease agent on to others
- ***Infectiousness*** is the comparative ease with which the disease is transmitted to other hosts.
- ***Immunes*** are people who already had the disease or who have been vaccinated, and can no longer be infected
- A ***carrier*** *is* a symptomless person passing an infectious agent (or ***pathogen***) to the susceptible.
- ***Incubation period*** or ***latency*** is the time period it takes for a disease to manifest itself clinically on the individual after infection.
- A disease is said to be ***contagious*** if it is transmitted between individuals through physical contacts.
- The lesions caused by the bacteria to the tuberculosis patients are referred to as ***tubercle.***
- ***Prevalence*** is the total number of existing cases over a specific time frame, regardless of when the disease began. Prevalent cases therefore include people who recently contracted the disease (incident cases) and those who contracted the disease earlier.
- A disease is said to be ***endemic*** when it is constantly present in an area; it is ***epidemic*** when it occurs at levels beyond normal expectation and is derived from a propagated source
- A disease is said to be ***pandemic*** when it is prevalent throughout the country or region.
- ***Aetiology*** refers to the cause or causes of a disease
- V***irulence*** is the degree of pathogenocity or the relative capacity of a disease agent to cause a disease.
- ***Place of origin*** refers to both the home state and home town where the respondent claims to have come from.

UNIVERSITY OF IBADAN

- A ***stop-over place*** is a settlement (temporary or permanent) where a Fulani camps with his livestock and/or family for at least two days but not more than one month, before proceeding to his destination where he spends more time.
- A ***place of destination*** is that in which a Fulani spends at least one month with his livestock and/or family and starts to make a return journey northwards.

1.6 Justification for the study

The choice of the topic is not without reasons. It is fascinating to see the Fulani migrate seasonally to the southern part of the country to pasture their livestock. It is also fascinating to imagine fluctuations in the availability of cow milk or its by-products in different places along the routes of migration of the Fulani. It is again fascinating to think of the lifestyle of the Fulani as affecting disease transmission from one place to another. The choice of the topic was therefore informed by these fascinations; the Fulani could serve as vehicles for tuberculosis transmission within the Northwest Region and the unpasteurized milk and the Fulani lifestyle could facilitate tuberculosis infection. This is particularly so when considering the Fulani lifestyle in terms of proximity with their livestock, the unpasteurized milk diet while in the bush and the likelihood of absconding from DOTS treatment. This study therefore looked at the intricate relationships between mobility (and its associated characteristics) as a life course and the transmission of tuberculosis within the region.

As for the study area, the choice was based on the fact that tuberculosis could be a public health problem in the region due to high poverty level (NBS, 2012), drier climate and a high population of livestock (Blench, 1999) that could give rise to zoonoses. The later factors could not only promote high prevalence of tuberculosis in the region but also ensure the transmission of the disease. The choice of the study area was also informed by the researcher's familiarity with the environment. It is the region within which the researcher happened to have come from. Therefore, the relative ease of collecting data from different government agencies and the local people was paramount in informing the decision to work in the area. Similarly, knowledge of the geography of areas along the routes helped tremendously in accessing the sampled locations. The area is also geographically and politically well-defined for this kind of study to be carried out.

UNIVERSITY OF IBADAN

1.7 Structure of the thesis

This thesis is divided into nine chapters. The first chapter gives a general introduction of the thesis, stating the background to the study, statement of research problem, aim and objectives, definition of terms, working hypotheses, justification for the choice of the topic and structure of the thesis. Chapter Two is on the conceptual/theoretical frameworks and the literature review, detailing the disease ecology approach and the distance decay model, Tuberculosis as a zoonosis, risk factors and socio-economic correlates in tuberculosis prevalence, barriers in disease transmission, human mobility and disease transmission. This chapter therefore provided the methodology for the study. Chapter Three focuses on the methods used in data collection, data generation and data analyses. It states in detail, all the stages involved as well as the limitations of some of the methods used and the data generated. The fourth chapter is on the location as well as the physical and socio-economic characteristics of the study area. Chapter Five presents a spatio-temporal analysis of the prevalence of tuberculosis, focusing on the monthly and spatial variations at various health (DOTS) centres along the Fulani route of migration. It therefore looked at the roles of *space* and *time* in the pattern of spread. Chapter Six discusses factors affecting tuberculosis prevalence. In particular, it looks at the roles of distance (along the route and away from it), population size, duration of stay of Fulani pastoralists, number of health facilities in a settlement where samples were taken, as well as age and gender of cases in affecting tuberculosis prevalence. Chapter Seven examines the environmental risk factors, whilst Chapter Eight discusses the socio-economic correlates that affect tuberculosis prevalence. Chapter Nine is the summary, conclusion and recommendations.

UNIVERSITY OF IBADAN

CHAPTER TWO

THEORETICAL/CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Introduction

Analysis of data on spatial spread of disease usually varies with the background of the researcher and the purpose that he intends to achieve. In this light, different kinds of conceptual and theoretical models are used by different individuals to serve as framework. Some of these could be purely mathematical, while others come from a body of established concepts and theories, but the basis is always an understanding and measurement of factors responsible for the process and their interactions. The framework is intended to shed light on the context within which the process operates. This chapter reviews the literature on the spatial spread of diseases, with particular reference to tuberculosis, as well as provides a conceptual/theoretical framework within which the study was carried out.

2.2 Theoretical and conceptual frameworks

The dynamics of the spatial spread of diseases are difficult to figure out as it requires looking at both the objects as well as the operations (i.e tuberculosis and migration in our case) working together to create the process of spread from our own perspective. In our case, we consider what the integrating framework is likely to be between geographic space, the process, and the entities that are affected by the process. We also considered what factors, constraints and barriers existed in the geographic space that can hinder or enhance the spread.

This research examined the prevalence of tuberculosis in the North-west region of Nigeria using the theoretical framework of disease ecology, which stipulates that an understanding of the prevalence of a disease requires a side by side understanding of the prevailing socio-economic/behavioural, cultural, environmental and biological characteristics of any population group, in addition to the characteristics of the disease agent itself. In other words, disease ecology is concerned with “the ways human

UNIVERSITY OF IBADAN

behaviour, in its cultural and socio-economic context, interacts with environmental conditions to produce or prevent disease" (Meade and Earickson, 2000). This is viewed as the "triangle of human ecology", with its three vertices representing culture, environment and population, interacting to determine the status of health of a people. Culture, in this framework, has to do with practices, belief systems, perceptions and behaviours such as consumption of unpasteurized milk as well as migration as a lifestyle factor. On the other hand, the environment here represents socio-economic characteristics of the people such as income and literacy levels, relationship with a tuberculosis index case, proximity to index cases as well as history of infection with tuberculosis or other related diseases. Conversely, population connotes demographic characteristics of people as organisms such as gender, age group and ethnicity. This holistic approach captures the essential elements embodied in disease ecology and their relationships in affecting health. The abstraction can therefore be used to study the prevalence of tuberculosis in the North-west region of Nigeria.

Distance along and away from the route of migration is also considered here a variable that affects the prevalence of tuberculosis through availability (or otherwise) of unpasteurized milk and its by-products at these places. Distance signifies the levels of interaction between places of origin and destinations of Fulani seasonal migrants. For this reason, the research made use of one of the spatial interaction models, *the gravity model* that also entails the distance decay theory (Rotheringham, 1981), to serve as a framework that will guide analyses. Generally, spatial interaction models analyze and predict flows of people, information, goods and services from one place to another. The basic principle of the distance decay theory is that interaction between places decreases with increase in both distance and population size of settlements. Given these scenarios, it is therefore possible to estimate disease prevalence based on distances between places, and their population size. Movement of people between places is therefore essential in the spread of diseases.

By incorporating time and space, along with basic epidemiologic concepts, the spatial interaction models can predict how tuberculosis can be transmitted from infected to susceptible people in an area and from one location to another. The distance decay model here considered transmission of tuberculosis, measured by the number of

UNIVERSITY OF IBADAN

reported prevalence cases, between an origin and a destination as a function of their attributes and the friction of distance between them. The general (Rotheringham, 1981) (but modified to suit our purpose) formulation of the model is given by:

$T_{ij} = f(V_i, W_j, S_{ij})$ where,

- ❖ T_{ij} : Interaction between location *i* (origin) and location *j* (stop-over and destination) in months;
- ❖ V_i : Socio-economic correlates and the environmental risk factors attributes of the origin *I*;.
- ❖ *Wj* : Socio-economic correlates and environmental risk factors attributes of the stop-over and destination *j; and*
- ❖ S_{ij} : Distance between the location of origin *i* and the location of stop-over and destination *j*.

The attributes of *V* and *W* are paired so as to measure interactions between all the possible location pairs. Thus, the greater the number of people who live in any of the two places, the greater will be the likelihood of contact between them, and thus the greater would be the prevalence rate. Conversely, the further apart the two places are from each other, the less the likelihood of contacts between them and therefore the less the spread of the disease between them. Our conceptual framework is therefore based on measuring and understanding (1) environmental risk factors (2) socio-economic correlates and demographic characteristics of the sample population as attributes of the areas of origin, stop-over and destinations of Fulani seasonal migrants in analyzing tuberculosis transmission within the Northwest Region of Nigeria. These factors are known to vary spatially in affecting disease epidemiology and disease etiology both individually and collectively. The two outlined frameworks were therefore used to guide this research work.

2.3 Barriers in disease transmission

There could be a number of constraints or barriers to the disease spread process, such as physiographic features (i.e. mountains, deserts, water bodies, etc.), political boundaries, linguistic barriers, and differences in control programs. For instance, the presence of hills and mountains, thick forests and rivers between settlements may hinder movement of people across these features and thus reduce contacts between

UNIVERSITY OF IBADAN

them and possible transmission of a disease (Vander Wal *et al*, 2012). Furthermore border restrictions between states or nations could limit the level of interaction of their people which may affect levels of contact and possible disease transmission (CDC, 2008). Ability to communicate with spoken language between people particularly in the local settings, also affects their commercial activities and thus the level of contacts (Givaudan *et al*, 2002). Finally, where disease control measures are not uniform across a region (i.e where some are vaccinated while others are not), the vaccinated group may become immune to the disease, giving rise to an absorptive barrier (Misra *et al*, 2012).

When physical barriers such as large water bodies and mountain ranges block or channel the transmission of a disease, they also help to slow down or deflect the process. It is probale, for instance, that Niger and Benue rivers in Nigeria might have limited the incidence of cerebral meningitis mainly to the drier northern parts of the country and blocked its spread to the southern parts. Social barriers such as class differences and racial groupings could also serve as barriers to disease spread. This is particularly so because different racial and ethnic groups do have different belief systems concerning disease causation, transmission and health-seeking behaviours. There is also a great divide between the rich and the poor, the elite and the illiterate, as well as between the employed and the unemployed within the society that creates barriers to disease transmission. This is particularly so with the homosexuals as a social group in transmitting HIV/AIDS. Thus, the pattern of disease transmission and spread could be determined by both the configuration of the networks (both socio-economic and physical) that encourage movement and barriers that discourage it.

2.4 Literature review

2.4.1 Human mobility and disease transmission

Meade and Earickson (2000:10-13) have stressed the importance of examining the movements of individuals or populations and the consequence of that on the spread of infectious diseases. Patterns of mobility and frequency of contacts affect transmission of contagious diseases or the exposure of people to disease transmission. Generally, movement causes people to circulate between micro-environments and exposes them to new pathogens and health hazards. Sick people may relocate given the severity of

UNIVERSITY OF IBADAN

the illness - for example urban residents who contract a terminal disease moving back to their home towns given that they may be too ill to care for themselves and may need assistance of their relations.

Movements of people could be involuntary due to environmental catastrophes such as droughts, floods, war or genocides which can give rise to exposure to disease and its transmissions. There could also be voluntary movements such as seasonal and periodic migrations. When a *carrier* (a symptomless person passing an infectious agent) moves, he or she can infect people along the way and at the destination. Conversely, if a traveller is susceptible to an infection, he or she will probably become sick if the infection is endemic in the destination area, and "because travellers are usually under some psychological and bio-meteorological stress, they are all the more susceptible to such infections" (Meade and Earickson, 2000: 119). Cetron *et al* (1998: 2) argue that "If travellers are responsible for the spread of infectious agents, they are also ideal sentinels for the arrival of an infectious agent in a new community", emphasizing that "in 1969, the first documented outbreak of lassa fever was noted among American missionaries in Lagos, Nigeria".

To buttress the fact that human mobility may be related to disease spread, Hardie *et al* (2007) carried out a study of infectious diarrhoea among tourists from the United Kingdom staying in a Resort Hotel in Greece. Of the 86 booking groups, 51 groups were contacted and interviewed, 94% of which were ill while on holiday or within a few days of return; diarrhoea was more commonly reported (95%) than stomach cramps (82%) or vomiting (64%). When asked about problems with the food or water in Greece during their travels, thirty-two identified problems with food, twenty-seven with room water and seven with drinks reconstituted with tap water. Among persons who were ill, 31% were categorized as definite cases; 48% as probable cases; and 21% as possible cases. Evidence suggests that two principal illnesses, viral gastroenteritis and giardiasis - both due to sewage contamination of the water supply, were responsible for the outbreak

Babatola (2006) also carried out a study on international population mobility and the risk of sexually transmitted infection (STI) among business operatives in Lagos with the aim of analyzing the sexual orientations of Lagos-based International Commercial

UNIVERSITY OF IBADAN

Circulators (LICC). This was to ascertain the extent to which such orientations are risk-prone and the extent to which circulators and non-circulators can be differentiated on the basis of the prevalence of sexually transmitted infections (STIs). Questionnaires were administered on socio-economic and demographic profiles; national information and knowledge about HIV/AIDS; previous experiences of sexually transmitted infections; sexual practices and attitudes; as well as documentation of former trips to international destinations and their accompanying sexual relationships. Student's t-test statistic, Chi-square test, Spearman Correlation and Logistic Regression were used as analytical tools. The study found that when sexuality risk was operationalized in the context of multi-partner sex, the circulators were more vulnerable than their non-circulators. Thus, the types of mobility as well as the activities associated with them are important elements in disease spread. According to Meade and Earickson (2000), the study of population movements helps to understand the human ecology of disease for a holistic analysis and understanding of the systems that result in human health or disease

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2.4.2 Factors of spatial transmission of diseases

According to Meade and Erickson (2000: 262), geographers' interest in infectious disease transmission rests, "not only on how a disease spreads in a population [mechanism] but how that spread occurs over space [dynamics]; not only how many cases might occur at a future point in time [constraints and barriers] but where those cases are likely to occur [locations]". The extent and form of human interactions, which are themselves influenced by distance, the location of settlements, and the distribution of opportunities and resources, play a vital role in the disease transmission process. However the transmission of a disease is also "a function of the characteristics of the disease agent itself (e.g. virulence, incubation period, mode of transmission, etc.) and the population which it affects" (Wallace *et al*, 1997) as well as other risk factors, such as age, smoking, and chronic lung or heart disease.

The factors that encourage disease transmission are so complex and diverse to the point that they need to be considered in totality. Interactions between social, economic, political and even cultural factors effect disease transmission (Peter *et al*, 1997). Whether one gets infected with a disease or not depends on the levels of

UNIVERSITY OF IBADAN

participation (social structural influences) within the society, which are in turn dependent on housing quality and location, social networks formed, the quality of encounters one experiences with others and so forth. Lifestyle factors, such as smoking could be a stress-coping behaviour that may be a determinant of health outcome. To demonstrate the role of lifestyle of a people in affecting health status, Peter *et al* (1997) examined the health status and risk factors of semi-nomadic pastoralists in Mongolia using a geographical approach. The objective was to establish the relationship that exists between health status, life style and the physical, medical and social environments of the target group. This viewpoint had earlier been stressed by Smith (1982: 4) who observes that:

> "The level of health of people in a particular locality must be seen as the outcome of a complex of interrelated conditions. The individual and the state are involved with the environment and with the health care system, within the overall structure of the economy-society-polity".

Peter *et al* (1997)'s study chose three target areas to represent economic, social, cultural and ecological cross-sections based on geographic coverage of the major ethnic groups, and logistical and political feasibility. A socio-medical questionnaire was used to gather information concerning the health, demographic, socio-economic, behavioural and environmental characteristics of the households and chi-square contingency analysis was carried out on the risk factors. The study found significant associations between certain health status indicators and gender, location, lifestyle factors, socio-economic status, preventive health care and the physical environment. It argued that a basis had been provided for a study on the relationships between geographic mobility characteristics of nomadic lifestyle and health status levels

Social networks and community influences, living and working conditions and access to services and facilities are also found to impact on health. Social networks for instance, provide social support (in form of finance, advise, etc) in times of stress as pointed out by Wallace *et al* (1977). To demonstrate the influence of socio-geographic networks on disease transmission, Wallace *et al* (1997) examined the relationship between community marginalization and the hierarchical diffusion of disease and disorder among eight metropolitan areas in the United States along transport networks on the basis of daily journey to work. They viewed the relationship

UNIVERSITY OF IBADAN

as an indication of social disintegration due to a deliberate policy aimed at weakening social networks through planned shrinkage and sheer neglect. They examined the patterns of incidence of AIDS and tuberculosis, low birth weight babies per 10 000 live births, and the incidence of violent crime. In particular, the spread of AIDS among the largest metropolitan areas was determined by the occurrence of violent crimes and the probability of contact with the most heavily infected epicentres (New York and San Francisco). The conclusion drawn was that incidence in the central city determines the incidence in the surrounding counties via economic linkages, as indicated by the density of the commuting pattern. Thus disintegration of the neighbourhood due to policy of neglect will result to further weakening of the weak ties between the city and suburbs, thereby lessening contacts and narrowing opportunities. Thus in a similar vain, diseases related to these contacts will disappear completely. Particular disease transmission patterns may therefore be governed by political, social, and cultural characteristics of the origins and destinations of migrants, as well as the reasons for migration.

The role of physical distance in disease transmission is very prominent, particularly with infectious diseases. When a carrier moves, he or she infects people along the way and at the destination. The basic assumption is that flows are a function of the attributes of origin and destination, and the distance separating them. Thus, the probability of contacts and interactions among people between two places depends on the distance separating them as well as the population characteristics of the two locations. As settlement size increases, the chances of contacts increase, for example. The greater the distance between the origin and destination of migration, the less will be the level of interaction and invariably the level of contact. Thus, modelling the spatial dimension of the disease transmission process by geographers usually involves using basic principles in *spatial interaction* models – such as the "Gravity" and "Distance decay" models (e.g. Nakaya, 2001and Chun-Lin *et al*, 2007)), which quite often take the form of an exponential function of distance with a negative exponent. This approach focuses on the processes and patterns of disease spread, arguing that movement plays a significant role in explaining disease patterns rather than environmental factors, which may only account for the survival and existence of the disease vector. The role of human mobility in disease transmission had earlier been demonstrated by Babatola (2006) and Hardie *et al* (2007).

UNIVERSITY OF IBADAN

Other issues of importance in determining risk for disease and health include poverty, inequality, discrimination and crime which have hitherto been neglected by even the behavioural paradigm that emphasizes the importance of perception in decision-making and spatial behaviour. The issue of justice and equity in the spatial allocation and distribution of material benefits and burdens of society are relevant in affecting health outcomes. In Nigeria, Okafor (2008:17) has observed that 'states and regions or zones with sizable rural populations are disadvantaged with regard to access to some public goods and services', which will obviously reflect on the people's health outcomes since access to health services is a function of cost in terms of transport fare, travel time and physical distance.

2.4.3 Tuberculosis as a zoonotic disease

Zoonosis refers to the ability of a disease agent to jump between animals, from animals to humans or vice versa and get adapted to its new host. The works of Davies (2006) and HPA, (2009) demonstrate the cross adaptability of *Mycobacterium bovis* in transmitting tuberculosis from animals to humans. Ayele *et al* (2004: 924) for instance, are of the view that "an unknown proportion of [TB] cases [in Africa] is due to *M. bovis,* which is underreported as a result of the diagnostic limitations of many laboratories in distinguishing *M. bovis* from *M. tuberculosis".* They argued that *M. bovis* closely resembles *M. tuberculosis* or may be clinically indistinguishable (Cosvi *et al*, 1998) and few laboratories are capable of differentiating the two and other members of the *M. tuberculosis* complex (MTC). For these reasons, pulmonary tuberculosis referred to in the present study is any form of human pulmonary tuberculosis regardless of the causative agent.

Idigbe *et al* (1986) have documented a 3.9% incidence rate of bovine tuberculosis in humans in Lagos, Nigeria. They reported that of the 2,784 humans who experienced lower respiratory tract infections, 668 were randomly selected and screened for pulmonary tuberculosis. *M. tuberculosis* was found to contain 87 (85%) cases, *M. bovis* 4 (4%) and atypical (environmental) mycobacteria 11 (11%). According to Daborn *et al* (1996: 927), pulmonary tuberculosis due to *M. bovis* is more common in rural dwellers, as a result of inhalation of dust particles or bacteria-containing aerosols shed by infected animals. Cosvi *et al* (1998) have estimated the global prevalence of

UNIVERSITY OF IBADAN

human tuberculosis due to *M. bovis* at 3.1% of all human tuberculosis cases, accounting for 2.1% and 9.4% of pulmonary and extra-pulmonary tuberculosis cases respectively. Mawak *et al* (2006) have reported Alhaji *et al* (1977) of having found a 10% incidence rate of *M. bovis* in four Northern States of Nigeria. They have also shown that of the sixty TB strains recently studied by them, *M. tuberculosis* was responsible for fifty-one cases, *M. africanum* for six, and *M. bovis* for three. Also, of the sixty five mycobacterial isolates examined by Cadmus *et al* (2006), *M. tuberculosis* was found to be 61.54%, *M. bovis* 23.08% and environmental mycobacteria 23.08%.

Ofukwu (2006) also reports that zoonotic tuberculosis due to *M. bovis* accounts for 5% of all cases of tuberculosis in humans in Nigeria, pointing out that 2.4% of samples of pus, urine and sputum collected from patients in a study were characterized as *M. bovis* while *M. tuberculosis* accounted for 82.3%. In Ethiopia, Shitaye *et al.* (2007) reported 16.7% of forty-two human isolates identified as *M. bovis.* The isolation and identification of *M. Bovis* in fresh and sour milk (called *nono* in Hausa) has been reported by Abubakar (2011) and Ofukwu *et al.* (2008), and the human cases of tuberculosis associated with the virus infection, both pulmonary and extra-pulmonary, have been stated (Idigbe *et al.*, 1986; Cadmus *et al.*, 2004). Abubakar *et al* (2011) concluded that even though the prevalence of *M. bovis* infection is low compared with that of *M. tuberculosis* infection, indications show a high possibility through direct contact with infected and diseased herdsmen as well as through consumption of unpateurized or sour milk (*nono*). Though found only in small proportions in humans, the presence of *M. bovis* in humans is still significant, as it shows zoonotic infection.

Microbacterrium bovis infection is transmissible from cattle to humans through direct contact with material contaminated with nose and mouth secretions from an infected herd of cattle (Beals, 2007). Research findings revealed that at-risk individuals are persons in contact with potentially infected animals such as milkers (Ofukwu, 2006; Yumi *et al.*, 2007). Indirectly, man acquires the disease from animal sources by consumption of unpasteurised infected milk (Thoen *et al.*, 2006 and Abubakar *et al.*, 2011). Ayele *et al* (2004:296) assert that ‘consumption of unpasteurized milk, poorly heat-treated meat and close contact with infected animals represent the main sources

UNIVERSITY OF IBADAN

of infection for humans'. This is a course of concern among the Fulani and rural dwellers in Nigeria where humans and animals share the same microenvironment and dwelling premises (Shitaye *et al.*, 2007).

The burden of tuberculosis could cut across all age groups of susceptible hosts. In countries where bovine TB is uncontrolled, most human cases occur in young persons and result from drinking or handling contaminated milk (Cosvi, *et al*, 1998:63). Kirk (2003) and Ofukwu (2006) are of the view that children are most often affected whilst Davies (2006) and HPA (2009) concur that most cases of the disease are in the older age. Ofukwu (2006) believes that up to 3% of zoonotic tuberculosis cases due to *M. bovis* in Nigeria is in children less than five years of age. In the Gambia, Touray *et al* (2010: 664) assert that tuberculosis mostly affects the productive age groups (fifteen to forty-five years) with a male to female ratio of 2:1. Whatever the case might be, pulmonary tuberculosis can be caused by either *M. tuberculosis* or *M. bovis*.

2.4.4 Risk factors in tuberculosis infection

A number of scholars have examined the types and variety of factors responsible for getting exposed to or infected from tuberculosis. Some of the factors relate to the individual's physiologic set up and immunity characteristics, while others relate to the physical environment in which the individual lives. Still, other factors are purely socio-economic or may even be affected by the State in terms of its roles and responsibilities. Thus, infection with tuberculosis has been shown to be a result of a complex interaction between the environment, the host and the pathogen (Lonnroth *et al*, 2009; Yim *et al*, 2010). The disturbing issue however is that, a large number of studies examining the effect of risk factors on tuberculosis did not differentiate between infection and development of the disease, thus confusing the effect of these factors on the risk of becoming infected and on the risk of developing the disease after infection. This is perhaps because majority of the writers are clinicians or medical personnel.

The risk factors can be categorized as *distal* (such as socio-economic status which contributes to the development of TB indirectly) or *proximate* factors (determinants that include those that increase exposure to the infectious agent such as crowding and

UNIVERSITY OF IBADAN

those that impair the host immune system). Mohammed *et al* (2011) have found out that among the distal determinants of TB infection, educational status was significantly associated with active TB which is consistent with the works of Hussain *et al* (2003) and Shetty *et al* (2006). According to Gatrell (2006: 113), 'family background influences educational opportunity and attainment, which in turn are powerful predictors of adult employment and income; these impact directly upon health'. Access to material resources may influence income, which in turn influences the ability to maintain good nutrition. Regardless of the geographic scale and resolution, current health may reflect previous places of residence rather than the present one (Gatrell, 2006: 181).

i) Environmental Risk Factors

Overcrowding is one of the environmental factors that promote the transmission and infection of tuberculosis as it is usually associated with poverty and increased susceptibility to the disease (Wanyeki *et al*, 2006;; Beggs *et al*, 2003; Clark *et al*, 2002). It may increase both the likelihood of exposure and progression to the disease (Clark *et al*, 2002), as well as serve as a risk factor for its transmission (Hawker *et al*, 1999; Beggs *et al*, 2003). The risk of exposure is particularly increased if there is limited air movement in an enclosed space (Beggs *et al*, 2003; Guwatudde *et al* 2003). Reports by Lienhardt *et al* (2005), Hill *et al* (2006) and Gustafson *et al* (2004) have shown that poor households and crowding were major risk factors for the development of tuberculosis. Chigbu *et al* (2010:2-3) have also observed that the transmission of *M. tuberculosis* is favoured by dusty environment and contacts due to overcrowding, arguing that the risk of becoming infected depends on such factors as the relative virulence of the disease strain, the intensity of exposure to an infectious tuberculosis case (proximity and duration), and the susceptibility and immune status of the exposed individual. In the following section, we shall look at some of these factors in more detail

Lienhardt summarizes a number of studies showing that crowding is a risk factor for infection and for increased risk of disease after infection (Guwatudde *et al* 2003). It was for instance found that an increase of 0.1 persons per room (PPR) increased the risk of two or more cases of TB in a community by 40% (Clark *et al*, 2002) showing

UNIVERSITY OF IBADAN

greater prevalence in crowded spaces (Hawker *et al*, 1999; Beggs *et al*, 2003). Beggs *et al* (2003) noted that occupancy density, room volume and air change rate are all directly correlated with the number of new TB infections among persons who share airspace. Environmental factors related to housing that may enhance the likelihood of TB transmission include:

- exposure of susceptible individuals to an infectious person in a relatively small, enclosed space;
- inadequate ventilation that results in either insufficient dilution or removal of infectious droplet nuclei;
- recirculation of air containing infectious droplet nuclei;
- duration of exposure; and
- the susceptibility of the exposed person.

To demonstrate the role of crowding and other factors in tuberculosis infection and transmission, Hill *et al* (2006) undertook a clinic-based case control study on pulmonary TB patients who were 15 years and above, in The Gambia, aimed at identifying the risk factors using a structured questionnaire. Cases were selected and matched with controls. Information was collected on age, gender and ethnicity of patient, history of smoking, occupation of the head of the household and having another member of the household with TB disease. Odds ratios (OR) and their 95% confidence intervals (CI), were estimated using conditional logistic regression, with TB as an outcome while the likelihood ratio test was carried out to assess the association between the explanatory variables and the risk of TB as well as to test for interaction and trend. Univariate analyses were performed to examine the effect of each variable on the risk of TB and multivariate analysis was then carried out to include variables that showed an effect in the prediction of TB in the univariable analyses at the $p = 0.05$ level of significance. The study showed that members of the *Jola* ethnic group and smokers were significantly associated with TB, while trained professional workers had significantly lower risk. Also, in the multivariable analysis, the same variables, *Jola* ($p = 0.028$) and smoking ($p = 0.032$), remained significant risk factors, while professional workers also remained at significantly reduced risk ($p = 0.039$). In the univariable analysis, the highest category of household crowding, and a history of TB in another member of the household were all found to be associated

UNIVERSITY OF IBADAN

with TB disease. In the multivariate analysis, household crowding (likelihood ratio test for linear trend: p = 0.0013) and a history of TB in another household member (p < 0.0001) remained significant. Thus, overcrowding and a history of household exposure to a known TB case were the standout risk factors in the study, as well as being in the *Jola* ethnic group.

Chigbu *et al* (2010) also investigated the transmission of *Mycobacterium tuberculosis* among 168 Aba Federal Prison inmates, Nigeria. The subjects, aged 18-63 years, were evaluated for active tuberculosis (TB) through tuberculin skin testing (TST). The subjects' individual characteristics such as lifestyle, history of smoking, alcohol consumption, sexual behaviours and history of TB or contact with TB patient were obtained. Of the 168 subjects investigated, three (1.8%) were TB cases out of which one (2.7%) was among the 37 inmates in the age-group of 18-26 years, and two (3.8%) were in the age group 27- 35 years. The highest frequency (66.7%) of the TST positive individuals after the follow-up came from the group aged over 44 years. The lowest proportion (39.1%) was among those who had stayed for 6 months and below, while the highest (75.0%) was among those who had stayed for 42-48 months. Of the 155 inmates who completed the study, 83 (53.5%) tested TST-positive and 14 (16.9%) of them developed TB. It was therefore concluded that the duration of imprisonment had no influence on infection, and the transmission of the disease did not necessarily require sharing a cell with a TB case.

The risk that *Mycobacterium tuberculosis* can be transmitted from patients with active tuberculosis (TB) to other patients and healthcare workers has also been recognized by Singh *et al* (2005) who conducted a prospective, hospital-based, descriptive study of the prevalence of tuberculosis infection among children in household contact with adults having pulmonary tuberculosis in India with the aim of identifying the possible risk factors. Children below five years of age in contact with 200 TB-infected household adults underwent tuberculin skin test, which gave 95 (33.8%) positive cases. Nine of these cases were diagnosed as having tuberculosis among which seven were in contact with sputum positive adults. Thus, about one third of children in household contact with adult patients were infected and about 5% were suffering from the disease. The Student's *t* test was carried out for continuous variables and the Chi-square test for qualitative variables to test the significance of the relationships.

UNIVERSITY OF IBADAN

Multivariate logistic regression analysis was also carried out with positive tuberculin test as dependent outcome. The results indicated that contact with a sputum positive patient on the occurrence of positive tuberculin test was highly significant ($p < 0.0001$), with an odds ratio of 3.20 (95% CI 1.84 to 5.60). Younger age, contact with an adult who was sputum positive and exposure to environmental tobacco smoke among others, were found to be the important risk factors for transmission of the disease.

ii) Socio-economic risk factors

Several studies have shown that socio-economic status is a strong risk factor for occurrence of active tuberculosis (Tornce *et al*, 2004; Shetty *et al*, 2006; Lopez De Fede *et al*, 2008; Muniyandi *et al*, 2008; Mackenbach *et al*, 2008; Ogboi *et al*, 2010; Boccia *et al*, 2011; Gupta *et al*, 2011; Obuku *et al*, 2012). This is because socio-economic factors work at both the individual and community levels. Standards of living in a community may shape household socio-economic status, which in turn might influence individual opportunities (in terms of education, occupation, nutrition, housing quality and social interaction) and the health-related lifestyles (such as smoking, snuffing, games, recreation and alcoholism). Also, social risk factors act directly on biological variables as well as interact with each other. They may have an influence on environmental or life-style factors, which in turn affect biological variables. They may also influence the transmission of the infection within a population through various networks. Therefore, prevalent cases of TB are likely to represent the end point of several processes (such as the risk of TB infection, the risk of TB progression, the risk of inadequate health seeking behaviour, poor treatment and compliance), each of which may be affected by household socio-economic status.

Several examples can be cited to buttress the role of socio-economic factors in the transmission of tuberculosis. Tornce *et al* (2004) for example, have carried out a cross-sectional study on 500 household contacts aged less than 15 years in Bangkok, Thailand, with the aim of determining the prevalence of tuberculosis infection and its risk factors. A structured questionnaire regarding infected children and their contacts was administered to the child's parent or guardian who accompanied him/her to the health centre. Chi-square test was performed to assess associations between all categorical risk factors and tuberculin skin test positivity. Odds ratios and their 95%

UNIVERSITY OF IBADAN

confidence intervals were also calculated and factors found to be significantly associated with tuberculosis infection in Chi-square test were included in the multivariate generalized estimating equation (GEE) for determining the risk factors. The study found the prevalence of tuberculosis infection among household contacts to be 47.80% (95%CI = 43.41-52.19). The Chi-square test showed that close contacts exposed to index cases were eight times more likely to have tuberculosis infection (OR = 8.08, 95%CI = 5.18-12.62). The risk of positive tuberculin skin test in household contacts was also found to increase with duration of contact, but the prevalence of the positivity was however not significantly associated with gender and age of contact, age, education and occupation of index case, or family income. In the generalized estimating equation (GEE), the risk of tuberculosis infection was still significantly associated with close contact (adjusted OR = 3.31, 95%CI = 1.46- 7.45). The study therefore concluded that persons living in the household of a tuberculosis patient are at high risk of becoming infected and developing tuberculosis themselves.

Shetty *et al* (2006) also conducted a study in South India using a structured questionnaire, with the aim of evaluating the role of demographic, socio-economic and health-related risk factors in patients with tuberculosis. Samples were drawn from out-patient pulmonary TB patients, as well as age and sex-matched controls from among their relatives. Risk factor variables were grouped into demographic (such as marital status; religion; employment and occupation), socio-economic (such as household income per month and household possessions) and personal health-related factors (such as smoking, chronic disease and contact with a TB patient). Conditional logistic regression analysis was carried out on the variables and the results showed a significant association of higher education and income with not being a TB patient. Current smoking was not however associated with being a case of TB, but past smoking was. Chronic diseases and previous contact with a case of TB were also not significant factors.

Ogboi *et al* (2010) conducted a clinic-based study on 694 suspected pulmonary TB cases aged 8 years and above at a DOTS centre in Zaria, Nigeria, with the aim of determining their socio-demographic characteristics. Records of their ages, sex distribution, education, occupational status and sputum smear positive TB test results were obtained from the case register, which also indicated that males constituted

UNIVERSITY OF IBADAN

58.4% of the subjects while females were 41.6%. Also, 39.7% of the subjects were in the age group 20 - 29 years with a mean age of 32.78 ± 15.10, while 56.5% were employed as civil servants, petty traders and artisans, and 43.5% were unemployed. 76.2% of the subjects had some formal education while 24.2% had no form of education at all. 12% of the subjects tested positive for TB among which 7.4% were males while 4.6% were females. Chi-square statistics was used to test for significance of association between categorical variables. The test indicated a significant positive relationship between sputum smear positive TB cases and no formal education (X^2 = 10.24 df = 4 p < 0.05) as well as between sputum smear positive cases and unemployed (X^2 = 19.16 df = 5 p < 0.05). It was concluded that poor socio-economic status with its attendant poor education is associated with poor knowledge of TB, risks of infection and dissemination and access to health care.

Boccia *et al* (2011) conducted a case –control study of respondents from a population-based tuberculosis and HIV prevalence survey in two communities in Zambia with the aims of (1) quantifying the association between household socio-economic status (SES} and prevalent TB and (2) exploring the potential mechanisms through which household SES might affect risk of TB infection. A total of 100 cases and 300 controls were selected in detecting an odds ratio of 2 for TB individuals with low household SES with a study power of 80% and 5% significance. All TB cases detected in the TB/HIV prevalence survey were recruited whilst controls were randomly drawn from the pool of TB-free participants. The study hypothesised that household SES might affect the likelihood of TB infection by reducing the education and occupation opportunity of the individuals which may lead to TB either by increasing the likelihood of exposure to biological/behavioural risk factors or increasing the chance of contact with other TB cases. Two separate structured questionnaires were each used on the household SES and individual-level. The association between prevalent TB and household SES, and other relevant risk factors were assessed using conditional logistic regression to estimate adjusted odds ratios (aORs) and 95% confidence intervals. The likelihood ratio test was used to assess association of factors with being a case as well as interaction between factors and linear trend for ordered categorical variables. Results of the study indicated that low household SES had a strong effect on the odds of being a case of prevalent TB (OR=6.2, 95%) compared to the baseline. No socio-demographic factor was found to

UNIVERSITY OF IBADAN

be associated with prevalent TB. Among the behavioural risk factors, prevalent TB was associated with migration, which persisted after adjusting for household SES. No evidence of association was found between smoking and being a case of prevalent TB. Finally, among the TB exposure-related variables, having been in contact with persons with active TB in the 12 months prior the interview showed a strong association with TB which persisted after controlling for household SES.

Gupta *et al* (2011) conducted a retrospective analysis on 207 TB patients in Southern India with the aim of determining the frequency of underlying risk factors and the socio-economic impact based on occupation in the development of tuberculosis. Demographic data on age, sex and the occupation of the patients, as well as the underlying risk factors such as HIV infection, diabetes mellitus, history of contact to a smear-positive pulmonary TB patient and smoking were statistically evaluated using chi-square test and Fisher's exact test. Occupational impact was analysed by one-tail student t test. The study found pulmonary tuberculosis most prevalent in the age group 21–40 years (n = 86), followed by 41–60 years (n = 79), >60 years (n = 24) and <20 years (n = 18). It was also significantly more common among labourers (44%) and white-collar (27.1%) workers than household workers (12.1%), students (10.6%) and retired ⁄ unemployed people (6.3%).

Specifically among children, Nakaoka *et al* (2006) conducted a cross-sectional study of children in contact with adults who had pulmonary TB in Abuja, Nigeria with the aim of finding the degree of infectivity among them due to contacts with the case. Study children were randomly selected from households of adults diagnosed of TB. The parents were interviewed by using a standardized questionnaire concerning medical history, degree of contact, and characteristics of the household. A separate group of children less than 15 years of age who were not exposed to adults with TB was selected to serve as control in order to assess the prevalence of asymptomatic infections in the community. Student's *t* tests were used for comparing means of continuous variables. Chi-square test was used for categorical variables. Of the 207 children enrolled in the study, 83 were in contact with adults with smear-negative TB, 78 were in contact with adults with smear-positive TB, and 46 were community controls. 6 (15%) of control children and 13 (16%) of children in contact with adults that have smear-negative TB were positive. A larger proportion (53%) of children in

UNIVERSITY OF IBADAN

contact with adults with smear-positive TB were positive ($p<0.001$). The proportion of children with positive results increased with age in both control children and in children in contact with adults with smear-negative TB. The risk for infection after exposure to adults with smear-positive TB was 53% and therefore, the study concluded that exposure to adults with smear-positive TB was the most important risk factor for transmission within households.

Soborg *et al* (2011) have also tried to explore the risk factors for *Mycobacterium tuberculosis* infection (MTI) in Greenland using a cross-sectional design by testing the children for TB clinically and using a self-administered questionnaire to obtain information on crowding in the household, parents' educational level and the child's health status. Logistic regression model was used to check for associations between these variables and *M. tuberculosis* infection, and all results were expressed as odds ratios (ORs) and 95% confidence intervals (CIs). Infection was diagnosed in 26.7% of the children with a known TB contact, as opposed to 6.4% of the children without such contact. They determined whether a risk factor was modified by contact with a TB case by assessing for interactions between the risk factor and TB contact after adjustment for each adjustment variable. Of the 180 children with a reported TB contact, 31% reported a household contact, 22% reported a school contact and 47% did not specify the type of contact. It was found that contact with a patient with clinically active TB was significantly associated with positivity for MTI among other factors. The increased risk of MTI associated with living in crowded conditions might be the result of easier transmission of *M. tuberculosis* because of closer contact between family members particularly those infected with *M. tuberculosis*. It was concluded among others that ethnicity, number of household residents and maternal level of education are factors associated with the risk of TB infection among children in Greenland.

iii) Behavioural risk factors

A number of authors have also carried out studies to support the roles of behavioural factors. Gesler (2002: 196) has noted the role of cultural differences in creating different health belief practices and experiences. Religion in particular, affects the health and health behaviour among older adults. In the area of perception and health-seeking behaviour for example, prolonged delays in tuberculosis detection and

UNIVERSITY OF IBADAN

treatment due to the person's perception of disease may enhance continual transmission of the disease in the community. Oluwadare and Bosede (2010) have for instance conducted a study to examine the pattern of health-seeking behaviour on tuberculosis patients in Ekiti State, Nigeria. 117 out of the 125 TB patients interviewed were chosen for the study. The interview measured personal characteristics of the respondents, pattern of their health seeking, perception and attitude to treatment and general evaluation of the process of care. The study discovered that about two-third of the respondents have less than secondary education and that 52 and 43 percents of male and female respectively believe that TB is "slightly dangerous", thus indicating appreciable level of knowledge of the infection. Smoking habit and poverty were the most acknowledged causes of TB while poverty and drinking of alcohol were also mentioned. There were also other superstitious beliefs for the cause of TB, such as spiritual attack from enemies, ancestral curse and result of breaking of cultural taboos. The study concluded that belief about the nature of TB infection is a significant predictor of when and where treatment for the infection takes place and the greatest predictor of health seeking behaviour among the various social conditions of the respondents was the level of education, followed by gender and age.

Delay in seeking healthcare in tuberculosis detection and treatment is sometimes affected by the person's perception of disease as well as poor or lack of knowledge of the disease. To buttress this issue, Obuku *et al* (2012) carried out a study on the socio-economic determinants and prevalence of tuberculosis knowledge in Uganda with the aim of assessing knowledge of the disease and identifying the associated socio-demographic determinants in three urban centres using survey questionnaire on persons aged 18 years and above. The level of TB knowledge, stratified as knowledge of cause, symptoms, transmission, risk groups, prevention, and treatment was correlated with age, sex, marital status, educational level, employment and distance from health unit. This association was examined using the univariate analysis, with crude odds ratios (OR) and 95% confidence intervals. Tests were considered significant if $P < 0.05$ and potential determinants with $P < 0.25$ were included in a multivariable ordinal logistic regression model for the estimation of their adjusted odds ratios (aOR). Age, gender, education level, employment status, and distance from health were found to be significantly associated with TB knowledge at univariate analysis while older age (40 – 59 years; 1.73; 1.30 – 2.29, P < 0.001) was found to be associated with higher TB knowledge scores in the multivariable ordinal logistic regression model. Similarly, lack of formal education (0.56; 0.38 – 0.83, P = 0.004) and unemployment (0.67; 0.49 – 0.90, P = 0.0100) were found to be significant determinants of poor TB knowledge scores.

Cigarette smoking may also reflect poorer health related habits and socio-cultural behaviour that may independently increase risk of infection, including that of tuberculosis. It has been observed for instance that lifestyle, such as tobacco/cigarette smoking, could increase the chances of developing clinical TB four-fold (Lam *et al*, 2004; Arcavia, 2004, Ariyothai *et al*, 2004; Singh *et al*, 2005; Lien *et al*, 2009; Chigbu *et al* 2010 and Ekrakene and Igelele 2010). However, Dye *et al* (2009:689) have argued that tuberculosis incidence trends are usually correlated with numerous biological, social and economic variables, and therefore "strong correlation of a risk factor with tuberculosis trends does not necessarily reflect a causal link; conversely, the absence of a correlation does not exclude causality", stressing that even though tobacco smoking and diabetes are risk factors for tuberculosis, their study showed that the factors are associated with declining tuberculosis incidence, suggesting that these factors may reflect social patterns that are linked to health, health services and economic development in ways that override their importance as risk factors for tuberculosis.

Ekrakene and Igeleke (2010) also conducted a clinic-based cross-sectional study on 50 active smoking men and 50 passive smoking men randomly selected from the incoming patients in Central Hospital, Benin City, Nigeria, during a questionnaire survey. Subjects were diagnosed and tested for TB infection. The results indicated positive tests of *Mycobacterium tuberculosis* for both passive and active smokers alike, with active smokers having higher casualties. The study also showed more individuals from age group 36-40 were the most vulnerable compared to 25-30 age groups. The results revealed a high prevalence of pulmonary tuberculosis in age 36-40years (42.85%), followed by age 31-35years (33.33%) and then age 25- 30years (20%).

UNIVERSITY OF IBADAN

Globally, tuberculosis is believed to affect the most productive age group and that infection generally increases with age and then declines in older adults. There could also be sex differences in the distribution of tuberculosis disease which could reflect greater exposure among adult males because of differentiated social roles and economic activities, or perhaps a genuine sex difference in susceptibility to tuberculosis infection. Male gender is also usually associated with active tuberculosis due to a combination of behavioral, socio-economic, and biological/genetic factors (Mohammed *et al*, 2011; Yim *et al*, 2010; Lienhardt *et al*, 2005 and Singh *et al*, 2007).To substantiate this ascertion, the works of Lienhardt *et al* (2003), Itah and Udofia (2005), Lien *et al* (2009), Ekrakene and Igeleke (2010), Rafiza *et al* (2011) and Liao *et al* (2012) are notable examples.

Itah and Udofia, (2005) carried out a clinic-based study of the incidence of pulmonary tuberculosis in South-eastern Nigeria on both in-and out-patient cases of tuberculosis. Out of the 1,324 cases screened, the highest number of positive cases was from patients aged 16- 35 years with 55.2% incidence, followed by adults 36 years and above (29% incidence). The high incidence observed in ages 16-35 years was attributed to the fact that people in this category are at a very active period in their lives and are more likely to move around for their survival. Among the occupational groups, traders were found to have the highest incidence (33.8%), followed closely by health workers (31.0%). Similarly, males were also found to be more prone to pulmonary tuberculosis infection (35.6%) than females (26.9%), probably because, of their greater interaction with persons in different walks of life than the females.

Lien *et al* (2009) conducted a cross-sectional study in two adjacently located hospitals in Hanoi, Viet Nam, with the aim of estimating the prevalence and risk factors for TB infection among health workers. Demographic information and factors potentially associated with TB exposure such a job category, duration of work, practice of wearing mask, and professional or household contact with TB patients were collected among others using a structured questionnaire. Blood test for TB infection was also carried out on all the subjects. Chi-square test was used to compare proportions in two groups. The associations between potential risk factors and TB infection estimated by TB test positivity were also evaluated using a logistic regression model. In the Chi-square test, non-occupational factors such as age were found to be significantly

UNIVERSITY OF IBADAN

associated with having a positive TB test result (OR =1.05 [95%CI, 1.02–1.07] while TB test positivity was associated with non-occupational factors such as increase in age (OR= 1.06 [95%CI, 1.00–1.11]), education lower or equal to high school level (OR = 4.28 [95%CI, 1.28–14.27]) and pre-university level (OR = 3.54 [95%CI, 1.18–10.59]) in the regression model. Among occupational factors tested, working in TB hospital was the only parameter showing the significant association (OR = 1.94 [95%CI, 1.04–3.64]) with the TB test positivity.

Rafiza *et al* (2011) also conducted a cross sectional study among health care workers randomly selected from four hospitals with the aim of determining the prevalence and factors associated with latent tuberculosis infection (LTBI) among them. Respondents, which included nurses, medical assistants, medical laboratory technicians and office workers, were categorized into high and low risk based on exposure to patients with active tuberculosis. Sample size was determined based on a 4% prevalence in the low risk group and an adjusted odds ratio of 2.48 among the high risk group. A self-administered questionnaire was used to gather information on work history, history of previous TB and history of living in the same house with persons infected with active TB, as well as socio-demographic characteristics that serve as possible risk factors. Data were analysed using the multiple logistic regression model. Out of the 1050 questionnaires distributed, 954 (90.8%) responses were received, among which majority were females (88.0%) and nurses (76.0%) with a mean age of 29.2 years and mean duration of employment of 6.8 years. The univariable analysis showed significant high risk among those aged between 25 to 29 years and above 35 years, ever married and lived in the same house with TB-infected persons. Duration of employment 11 years and above was the only occupational factor found to be significantly associated with higher prevalence of latent tuberculosis infection while in the multivariable analysis however, persons aged 35 and above and those having history of living in the same house with TB-infected persons, worked as a nurse and being males, were found to be significantly associated.

Liao *et al* (2012) assessed the trends and predictors of tuberculosis in Taiwan using monthly TB data by gender, age groups and subpopulation groups. A Poisson regression model was used on mean age and ratio of male to female TB cases data to

UNIVERSITY OF IBADAN

assess the roles of aboriginal subpopulations, age and gender as potential predictors of TB trends. Results of the Poisson regression analysis showed that male and all age groups had highly significant effects on TB trends ($p < 0.001$). More than 90% of TB cases were found in adults aged 25-64 and older, with the largest proportion among those aged greater than 64 years, indicating that there is a trend of an increasing proportion of TB among the elderly. Also, there was high prevalence among males ($p < 0.001$), thus indicating that gender differences could be a factor accounting for the TB incidence.

Kehinde *et al* (2011) studied the magnitude of occupationally-acquired TB among 271 health care workers (HCWs) at two DOTS centers in Ibadan, Nigeria. A pre-tested questionnaire was used to obtain information on socio-demographic characteristics and medical history of the subjects, as well as previous tuberculosis vaccination, contact with an index case and exposure to tuberculin skin test. Data were analyzed using the Chi square test to measure the association between categorical variables. The study found 59.0% of the subjects working in their units for more than two years as TB cases. 93.7% reported negative history of chronic cough, while 94.8% denied any history of smoking. Also, 65.7% agreed to recently having contact with patients with chronic cough and 36.9% had a positive tuberculin skin test in the past. It was therefore concluded that the longer exposure was responsible for the highb rate of infection.

Another example is the work of Lienhardt *et al* (2003) who carried out a case control study on the role of the environment and host-related risk factors for tuberculosis infection in The Gambia. Questionnaires were distributed to all newly detected smear-positive pulmonary tuberculosis patients older than 15 years who have been living at the same address for more than 3 months, and information collected on the household size, the number of rooms and the structure of the house, hygiene conditions, water supply, sanitation, socio-economic indicators, duration of residence in the compound, close family ties and exposure to the tuberculosis case, past disease history, and as well as the presence of symptoms of tuberculosis. Exposure to the disease was evaluated through the assessment of the social proximity of the individual to the case within the household. Their finding showed an increase in the infection of tuberculosis with age, which was similar in both males and females up to the age of 15

UNIVERSITY OF IBADAN

to 20, after which it became higher in males. Generally, the risk of being infected was found to be higher in households that have tuberculosis cases, which increased with the duration of stay of the individual in the household, and among individuals with former history of tuberculosis. The risk of exposure of the household members to the case was also found to increase with the social proximity of the individual to the tuberculosis case. The conclusion was that the observed difference in the infection after adolescence might have reflected greater exposure among adult males because of their different social roles and economic activities, as well as differences in susceptibility to TB infection. The authors believed that the higher risk of TB infection among contacts of TB cases and its increase with the intimacy of contact with the case, is an indication that the risk of infection is associated with the intensity of exposure of the household member to the case, thus attributing crowding as responsible for the increase, since exposure to the disease is dependent on the degree of shared airspace. This argument is in consonance with works of Lienhardt *et al* (2005) and Hill *et al* (2006).

iv) Other risk factors

There could also be differences in tuberculosis risk among various ethnic or racial groups due to differences in exposure to the disease as well as differences in the prevalence of infection due to differences in socio-economic status among racial and ethnic groups. The work of Hill *et al* (2006) is a notable example.

In Nigeria, The Federal Ministry of Health (2004) has reported that 5% of the prevalence of tuberculosis in the country is due to HIV co-infection. It is also believed that consumption of *fura da nono* from unpasteurized milk or the sour milk (*nono*) itself may be responsible for the higher prevalence (Adebowale, 2008:30, Sharubutu, 2007). Improper meat inspection at the abattoirs and poor control programmes are also believed to be responsible for high tuberculosis prevalence. Again, socio-economic factors, poverty and poor health care systems (Nwacholor and Thomas, 2000), are some of the risk factors for the prevalence of TB in Southeast Nigeria. The risk factors and socio-economic correlates could thus vary, depending on the environment - physical, socio-economic.and cultural.

UNIVERSITY OF IBADAN

By and large, variation in prevalence, level of presentation and mortality from tuberculosis depends on prevailing social factors such as socio-economic status of the people, malnutrition, crowded living conditions, incidence of HIV/AIDS, level of development of health infrastructures, quality of available control programmes and degree of drug resistance to anti-tuberculous agents among other factors (Erahl *et al*, 2009:11).

UNIVERSITY OF IBADAN

CHAPTER THREE

THE RESEARCH METHOD

Introduction

This chapter discusses the methodols employed in this study. Specifically, the sampling frame and sampling methods are discussed, data types and the variables measured are defined and their limitations discussed, and the transhumance routes are identified. Finally, the chapter discusses the methods of data analysis.

3.1 Types of data

Two types of data were utilized i.e., primary and secondary data. The secondary data included case registry data of TB patients from different hospitals and clinics nearest to the route of migration at the origins, stop-over and destination settlements, as well as other settlements outside of these. It also included locality-based population census data for the 1991 national census which were projected to 2010, distances between places (computed from topographical maps), number and types of available health facilities in each settlement, as well as information pertaining to government control programmes.

The primary data included data on different demographic and socio-economic characteristics of the sampled population, as well as the environmental risk factors in the prevalence and spread of tuberclosis. Data were captured using the structured questionnaire as an instrument (see Appendix I). Specifically, the socio-economic and demographic characteristics of the sampled population included data on the following:

i) Marital status,

ii) Religion,

iii) Ethnicity,

iv) Age,

v) Gender,

vi) Occupation,

vii) Income,

viii) Literacy level, and

UNIVERSITY OF IBADAN

ix) Place of origin

'Occupation' is here defined as any income-generating activity (paid or unpaid) carried out by an individual to sustain himself/herself', whilst 'literacy level' is defined as the ability to read (with understanding), acquired through the Western education system (with or without a certificate). Finally, 'income' is any amount of money earned (on monthly or annual basis) by the respondent.

Environmental/behavioural risk factors included:

i) Number of persons per room,

ii) Habits such as smoking and alcoholism,

iii) History of taking fresh milk or its by-products,

iv) Personal hygiene and sanitation,

v) Contact with animals and other non-migrant populations,

vi) History of TB infection

The 'number of persons per room' refers to the number of family members that actually sleep in a single room, which gives an idea on the level of congestion. 'History of taking milk or its by-products' is the length of period (in completed months) the respondent had taken or has been taking unpasteurized milk or its by-products, and whether he/she had noticed any change in his/her health status during the period. 'Habits' were reported in terms of whether the respondent had been involved in a particular risk habit and for how long, and if so whether that has had any effect on his/her health. The question on 'personal hygiene and sanitation' pertains to how often the respondent takes his/her bath and changes clothes, as well as cleans his/her living environment (house and the surroundings). 'Contacts with animals and other populations' refers to how often the respondent stays with other people (as he/she performs economic/social functions or religious obligations) or his animals (as he takes care of them) so as to determine the degree of contact. 'History of TB infection' examined whether the respondent has had TB infection before and if so what was his/her level of compliance to treatment. It was also to know if he/she had ever stayed with a TB patient, so as to determine his level of exposure.

For the purpose of clarity, 'spread of the disease' refers to the diffusion of the disease from areas of higher prevalence to areas of lower prevalence, whilst 'prevalence' refer

UNIVERSITY OF IBADAN

to the number of TB cases reported in the sampled areas in relation to time and space, that is, the total number of existing cases over a specific time frame (within the year 2010) in different places.

3.2 Sources of data

Two sources of data were utilized i.e., field and archival sources. The archival sources included data from the different hospitals and clinics along the Fulani routes of seasonal migration as well as the National Population Commission. Data were also collected from the States' Ministries of Agriculture and Livestock Development, as well as the Departments of Agriculture and Natural Resources of the Local Governments so affected. The collection of field data involved the use of a structured questionnaire, the use of the Global Positioning System (GPS), as well as direct observations.

3.3 Methods of data collection

3.3.1 Reconnaissance survey

A rapid visit was paid to the States and LGAs within the region forming the study area with a view to identifying the Fulani leaders (*Ardos*) and Health centres, as well as undertaking preliminary assessment of the situation, identifying the principal issues, and fine-tuning strategies for data collection. This stage gave the opportunity to meet with the *Ardos* and officials of Ministries of Health, health centres, the National Population Commission and community leaders, and solicited for their support and co-operation. The health centres (for questionnaire administration), the migration routes and the stop-over places of Fulani in or near a settlement were also identified at this stage.

3.3.2 Secondary data collection

Case registry data on TB were collected from the health (DOTS) centres along the route for the determination of the spatial and temporal patterns of the disease and the 1991 census locality-based data were collected from the National Population Commission and later projected to 2010 (see Appendix II) to determine the population sizes of settlements where patients come from. In the same vain, some geographical

UNIVERSITY OF IBADAN

coordinates of the affected settlements were also collected from the National Population Commission for the determination of locations of settlements and computation of their distances to DOTS centres.

One of the limitations that confronted the researcher was that available case registry data were not equally available between DOTS centres and within the years because the DOTs programme could not start at the same time in all the centres such that while some centres had data for up to five years, others had for only two years. Notwithstanding, the study used the monthly data for 2010 only in analyzing the prevalence of TB since our focus was on the seasons. Precisely, the 2010 data were used as they were available for all centres and were the most up to date. Secondly, distances between DOTS centres and locations of patients were not readily available and these were determined from roads and footpaths on the topographical maps. Where these were not available, geographical coordinates (longitudes and latitudes) had to be used as proxies in computing straight line distances between them, which may not represent the actual distances covered due to the nature of the surface of the landscape. It was thought easier to use the coordinates because of the large number of settlements involved and the fact that the Fulani do not follow well-defined routes that could be measured during the course of seasonal migration. This may have some bearing on the outcomes of the analyses that relate to distances.

Again, getting the geographical coordinates was also another onerous task as some of these could not be obtained from the National Population Commission, nor could they be located on the base map. Therefore, locating the settlements could only be done for those whose coordinates were obtained from the National Population Commission the DOTS centres and those whose coordinates were recorded with GPS during field work, and those found on the base map were used in carrying out the analyses. This meant that some settlements had to be omitted in the analyses of distances in relation to prevalence. Similarly, population data for the year 2010 were also not readily available, as the National Population Commission was yet to release the locality-based 2006 National Census figures as at the time of the analyses. Therefore, the 2010 figures had to be projected from the 1991 figures. This may also have some bearing on the analyses of population data in relation to the TB prevalence. This is particularly so because the 1991 census lumped up populations of small settlements

UNIVERSITY OF IBADAN

thereby making it difficult to separate for individual settlements to serve our purpose. Yet another limitation could be that of the confounder effect since the population growth rate may not be uniform for all settlements and invariably, the projected figures may not represent the actual situation or still, the prevalence may simply be a function of the population size of settlements as a confounder. The issue of age and gender may also crop up as confounders since prevalence could be directly linked to these variables. There is also the issue of modifiable area unit (MAU) problem since the populations may not be evenly distributed in addition to the multiplicity of factors responsible for the prevalence.

3.3.3 Primary data collection

This exercise consisted of further visits to the sample study locations (DOTS centres) for questionnaire administration on the current TB patients so as to supplement information obtained during the archival data collection and provide the explanatory variables for the spatio-temporal analysis of the disease. The information collected focused mainly on the socio-economic, demographic and environmental risk factors of current TB patients who happen to come from both along and away from the route of Fulani seasonal movements. The variables captured included gender, age, marital status, personal hygiene and sanitation, income and occupation, contacts with animals and other people, access to and utilization of health care facilities and services, among others. The geographical references of the DOTS centres were also captured using the GPS during the field work.

One of the limitations is that a number of questions were not responded to or the interviewers did not capture them. One of the reasons could be the condition in which the interview took place. Perhaps the interviewees could have been very sick during the interview and were not able to respond to all questions or it could have simply been due to negligence of the interviewers. As at the time the questionnaires were to be retrieved, patients were not available to give answers for such questions. Again, the quality of the answers obtained varied with the DOTS Officers carrying out the interview and the respondent's age and gender. While some DOTS Officers were getting answers for all questions asked, others were not probing further to get all the required answers. This was particularly so with younger age groups. Therefore, for

UNIVERSITY OF IBADAN

many questions asked, the number of responses may not tally with the actual number of patients interviewed.

3.3.4 Sampling frame

Major settlements with Directly Observed Therapy (Treatment) Short course (DOTS) centres along the Fulani route of seasonal movement provided the sampling points where questionnaires were administered. Tuberculosis case registers in these DOTS (health) centres provided the list of all those diagnosed with tuberculosis (treated, currently receiving treatment, abscondments, or diseased) in the study area in the year 2010. It also provided some characteristics of the patients such as gender, addresses, ethnicity, age group, marital status, co-infection with HIV/AIDS and the type of tuberculosis. These case registers formed our sampling frame from which the sample of TB patients was drawn. That is, the current TB patients provided the sample for questionnaire administration, based on the premise that treatment of tuberculosis lasts for complete eight (8) months and whosoever is administered the questionnaire is deemed to be part of the population of patients registered within the eight-month period.

3.3.5 Sampling methods and sample size

In administering the questionnaire, a purposive but random sampling technique was employed. The study population consisted of all patients currently receiving treatment on TB in the DOTS (health) centres. Since the treatment for tuberculosis is for complete eight (8) months, except for relapses (failures), deaths and absconments, all patients registered for the past seven (7) months in the various DOTS centres (and expected to still be receiving treatment as at the time of the interview) were assessed. This component represented our study population from which the sample was drawn. In computing the proportion of sample for each of the health centres, the following steps were taken (Araoye, 2004):

- ✓ Estimate of the TB prevalence (*P*) was taken to be 50% so as to maximize the expected variance and ensure a representative sample,
- ✓ Degree of accuracy (*d*) required were set at 5% (0.05) level,
- ✓ The confidence level (*l*) were set at 95% (a z statistic value of 1.96 – standard normal deviate),

UNIVERSITY OF IBADAN

- ✓ The population size (*N*) was given as1736 (which was the total number of patients for all sample DOTS centres)
- ✓ The minimum difference that was statistically significant between the actual and control populations was set at 5%. Thus we estimated the sample size using a standard formula.When the population size is greater than 10,000, the formula for calculating the sample size is given by:

$$n = \frac{z^2pq}{d^2}$$

$$Therefore,\ n = \frac{(1.96)2\ (0.50)(0.05)}{(0.50)2} = 384$$

If we approximate the z statistic to the nearest whole number for convenience it is 2.0 then the sample size is

$$\text{n} = \frac{(2)^2\ (0.5)(0.05)}{(0.05)^2} = 400$$

Because our population (*N*) was less than 10,000, our final sample estimate was given by:

$$nf = \frac{n}{1 + \frac{(n)}{(N)}}$$

Where *nf* = the desired sample size when population is less than 10,000

n = desired sample size when population is more than 10,000

N = estimate of the population

Therefore; $nf = \frac{400}{1 + \frac{400}{1736}} = 461$

Thus our estimated sample for all the DOTS centres for the year 2010 was 461.

The sample was apportioned to different DOTS centres proportionately in accordance with the tuberculosis prevalence recorded by each in 2010. The sample was then drawn in each of the centres as patients come to take treatment or for diagnosis. As patients presented themselves for treatmenet and advice, questionnaires were administered on them. This method is refered to as ‘accidental/purposive/random’. It is accidental for the fact that respondents were captured only when they came to make contact with the physician in the DOTS centre. It is purposive for the fact that the

UNIVERSITY OF IBADAN

research is purposively targeted on the TB patients, and it is random for the fact that all patients had equal chances of being interwiewed and neither them nor the interwiewer had prior knowledge of who gets interviewed. Their choice was not predetermined by the interviewer and they also had no prior knowledeg that they were to be interviewed for them to get prerpared. Questionnaires were administered directly in the local languages by the DOTS Officers in their respective health centres. This boosted our confidence of having more reliable data, since questions were asked in the languages most understood by respondents. In addition, the respondents were willing to give information to DOTS Officers who advise and treat them.

3.3.6 Identification of transhumance routes

Before the seasonal migration starts, a Fulani usually knows where he is heading to and the route he is to follow. There could be numerous routes, depending on the interest of the Fulani and the opportunities that he knows to exist in a particular place. He could thus change to a particular route for a number of years or even limit his movement to certain locations for some periods. He also does not need to follow the nationally-marked transhumance route, but goes according to his convenience. Interviews with prominent Fulani leaders (*Ardos*) at Yabo and Dogondaji, indicated four major routes of seasonal migration at the northwest corridor. At some points, these routes diverge to grazing areas along the fadamas for pasture and water, or even the stipulated local grazing reserves. They all converge around major stop-over places like Gayari (Gummi LGA, Zamfara State) and their environs for a stipulated number of days, before proceeding in three directions that eventually merge at Kainji Bridge or go towards Mokwa (Niger State).

The areas of origin are in all the LGAs in Sokoto and Kebbi States and a few LGAs in Zamfara and Katsina States. The routes of the nomads could be categorized into three. The first route starts from Dogondaji, goes through Ganuwa, Gayari, Sabon Birni, Marafa, Tuwo, Saminaka, Dugu, Edehe, Wawa, Gadan Oli, Bagurasa, Kaima, Aboki, Garya, More, Bode-Ilesha and ends at Shaki. The second route is a replica of the first one, with divergence at Tuwo to Malam Tsoho through Giron Masa, Bakin Turu, Birnin Yauri, Makrin (Malando), Garin Baka, Ngaski, Dogon Kade, Amfani, Kainji

UNIVERSITY OF IBADAN

Bridge, Gadan Oli, Konkoje, Gabadori, Dutsin Gogo, Lili, Osa, Famini and ends at Bani. Yet another replica starts from Bagurasa through Kiama, Aboki, Gurya, More, Bode-Ilesha and ends at Shaki. The fourth route starts at Yabo with convergence from Wamakko and Silame and goes through Jabo, Gambandar Godabe, Gambandar Magiro, Gwalli, Garin Hausawa, Mahuta, Bajida, Dukku, Bakin Turu,, Birinin Yauri, Makrin (malando), Garin Baka, Ngaski, Soga,Garafuni, Kajapu, Amfani, Kainji Bridge, Sabon Hegi, Sabon Auru, Tsohon Auru, Rafin Gora, Farin Dutse, Maje, Famini and ends at Bani. These routes are represented in Figure 3.1. In all cases, Konkoje, Gabadori and Dutsin Gogo are temporary grazing settlements while Lili, Osa, Kiama, Aboki, Gurya, More, Bode-Ilesha, Shaki and Famini are permanent grazing settlements where the Fulani spend appreciable time during the year.

Movement along the routes is in both directions, depending on the season; northwards during the rainy season and southwards during the dry season. There could be other minor routes with less traffic, like the one that follows the national cattle route to Yauri (Kebbi State) without any divergence. However, information gathered showed that the major route shown on Figure 3.1 has the highest traffic, which made the researcher to concentrate on it. Also gathered from the field was the fact that there is minimal transhumance movement from the Nigeria-Niger boarder up to Gwadabawa (Sokoto State).

UNIVERSITY OF IBADAN

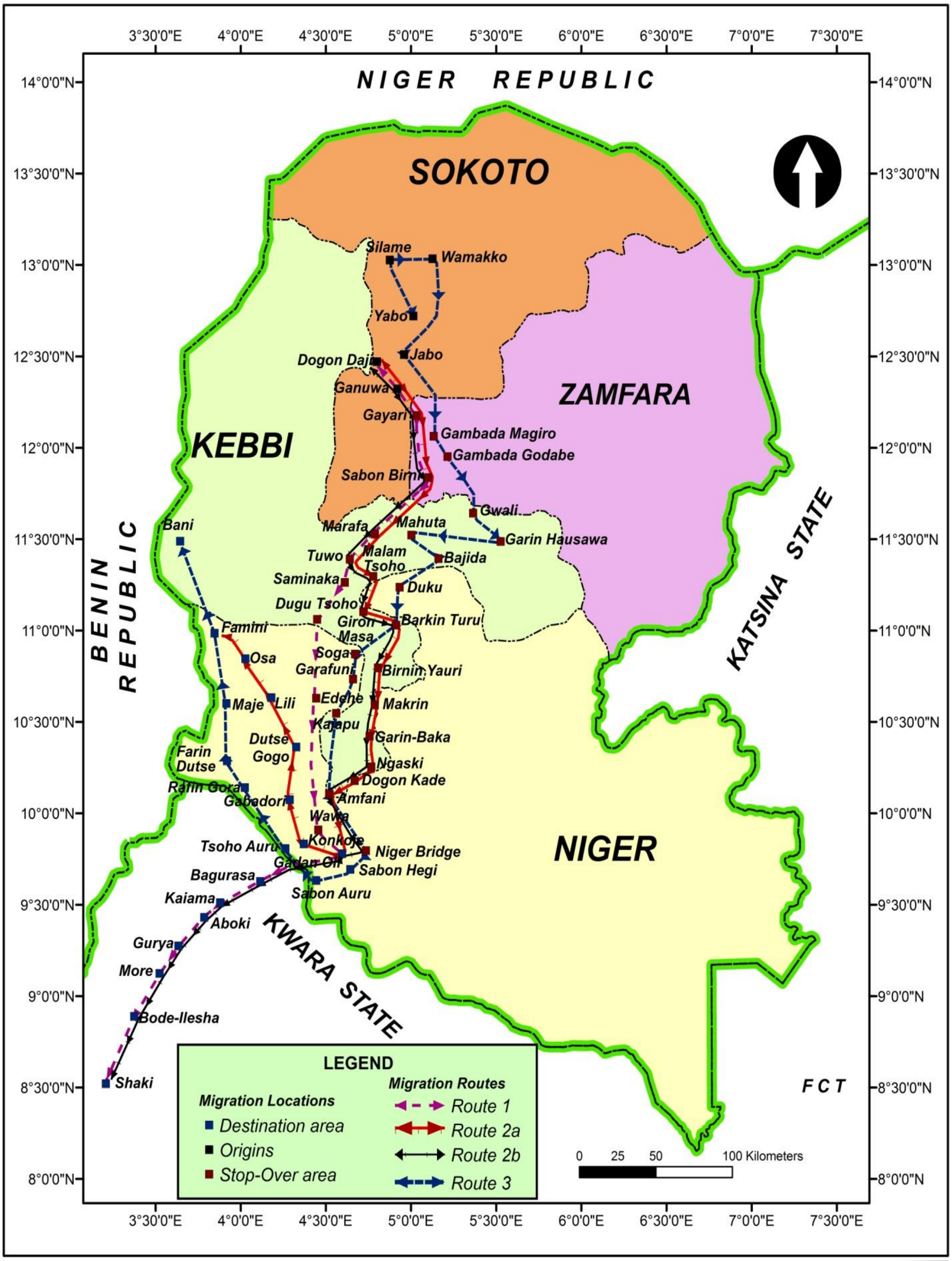

Figure 3.1: Fulani Migration Routes
Source: Fieldwork, January 2010

3.3.7 Creation of database

It has been stated that the 2010 locality-based population figures for the settlements where patients come from were not available and therefore projections had to be made. The population figures were projected using the exponential population growth rate:

$$A_f = A_b * (1 + \%/100)^{(f-b)}$$

where *A* is the population, *f* is the future year, *b* is the base year and % is the growth rate per year. At a growth rate of 3.4%, the 2010 population figures of the settlements were projected from the 1991 census figures (NPC, 1991, see Appendix II,). Similarly, distances between some DOTS centres and locations of patients were not readily available and their geographical coordinates (longitudes and latitudes) were used as proxies in computing straight line distances between them as well as direct measurements from topographical maps (see Appendix IV).

3.4 Methods of data analysis

Four statistical tools were used to identify relationships and test the hypotheses using the SPSS version 13. These are the Regression Analysis, the Pearson Correlation Analysis, Analysis of Variance (ANOVA) and the Test of Mean Difference (t-test). Microsoft Excel was also used to draw the bar charts.

3.4.1 The regression model

The regression model was used to assess the contributions of the variables in the hypotheses which state that: "environmental/behavioural risk factors play significant roles in determining the incidence of tuberculosis" and "socio-economic correlates determine the prevalence of TB in the region". The model describes relationship between a response (target) variable and a set of explanatory (predictor) variables. It is given by the formula:

$$Y_i = c_0+c_1X_{1i}+c_2X_{2i}+\ldots\ldots\ldots+.c_bX_{bi}+ u_i,$$

where c_0 is the intercept and a constant and X_1 to Xa are the predictor variables; c_0, c_1, c_2, c_3 and c_b are parameters to be estimated or the partial regression coefficients; u_i is

UNIVERSITY OF IBADAN

the multiplicative error term. In our case, tuberculosis prevalence (Y_i) was the response (target) variable, while environmental/behavioural risk factors were the explanatory (predictor) variables. The predictor variables included both the environmental risk factors, behavioural factors and the socio-economic correlates. The environmental risk factors consisted of 'ever been infected', 'ever been diagnosed of lung and heart-related diseases', 'ever suffered other illnesses', 'family member ever been infected', 'ever stayed with a TB patient', 'animal grazing on the fields', and 'exposure of job to dust'.The behavioural risk factors included 'sleeping in the midst of animals', 'consumption of unpasteurized milk', 'ever smoked cigarette' and 'ever visited a health centre'.

'Ever been infected' means that the patient had a history of infection consistent with his living environment, diet or lifestyle, and also lacks immunity to the disease as indicated by his/her current situation while "ever been diagnosed of lung and heart-related diseases" implies susceptibility to tuberculosis, particularly because the disease results in lung infection and earlier infection of the lung could mean an early stage of TB infection, which might have progressed to the current stage. "Ever suffered other illness" could signify reduction in immunity to infections particularly tuberculosis which is an opportunistic disease, and might have resulted to the current situation while "family member ever been infected" could imply proximity to the index case particularly if members of the same family sleep in the same room or share eating and drinking facilities and utensils . All these are environmental risk factors in the sense that they are directly affected by the environment within which the patient lives or interacts, or the environment of the pathogen where there is an historical account of the disease.

The socio-economic correlates are represented by 'access to healthcare services' , 'perception on the causes of TB' , 'ethnicity' , 'marital status', 'gender', 'work history', 'type of occupation', 'income level' and 'literacy level'. A regression coefficient (odds ratio) of 1.0 meant that the predictor in question had no effect on the response variable.

3.4.2 The Pearson correlation model

To assess the degree of association among the variables in the hypotheses which state that: "the prevalence of tuberculosis in the study area is a function of the number of

UNIVERSITY OF IBADAN

health care facilities" and "there is a positive relationship between duration of stay of nomadic Fulani and the prevalence of tuberculosis", The Pearson Product Moment Correlation Analysis was used. The model was also used to examine the relationship between prevalence and the risk factors and socio-economic correlates. The Pearson's correlation coefficient (*r*) defines the covariance between two variables divided by the product of their standard deviations. Thus the correlation coefficients range from −1.0 to +1.0. A value of +1.0 implies a perfect relationship between the dependent *(Y)* and the independent *(*X) variables, such that as *X* increases, Y also increases. A value of −1 implies that as *X* decreases, Y increases.

3.4.3 The analysis of variance (ANOVA)

To test the hypotheses which state that "environmental risk factors play significant roles in determining the prevalence of tuberculosis" and "socio-economic correlates such as work history, occupation, income, literacy level, access to health care and perception, affect the prevalence of TB in the region", analysis of variance (ANOVA) was used. The statistic was also used to test the role of duration of stay of Fulani in a place as well as seasonal patterns of tuberculosis prevalence among both the sample and control DOTS centres.

Analysis of variance (ANOVA) is a statistical technique that summarizes a classical linear model along with an associated F-test. The model tests for statistically significant differences between means (for groups or variables) and helps assess the sources of variation that can be linked to the independent variables and determine how those variables interact and affect the predicted variable. It yields a statistic, *F*, which is the ratio of the mean square between groups to the mean square within groups. To find the significance of the *F* value, one has to compare it with the critical *F* value with an alpha level of 0.05,. This comparison is usually done by the software such as the SPSS which was used. The output consists of the degrees of freedom which represent the number of effects at that level, minus the number of constraints for each source of variation, the total sum of squares and the mean square for each row, which is the sum of squares divided by degrees of freedom. If the *Between Group Variation* is significantly greater than the *Within Group Variation***,** then it is likely that there is a statistically significant difference between the groups. The statistic is given by the formula:

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$$F = \frac{\text{Variance between treatments}}{\text{Variance within treatments}}$$

$$F = \frac{MS_{\text{treatments}}}{MS_{\text{Error}}} = \frac{SS_{\text{treatments}/(I-1)}}{SS_{\text{Error}/(nr-1)}}$$

where *MS* is mean square, *I* = number of treatments and *nr* = total number of cases to the F-distribution with *I*-1, *nr* – 1 degrees of freedom.

3.4.4: Test of mean difference (Studdent's t-test)

This test was used to assess the statistical significance of gender, ethnicity, marital status and work history variables. The test tries to check the levels of relatedness of two sets of independent categorical measurements. It is used when only two sets of measurements are to be compared. It has the following assumption:

- there should be equal variances among the measurements;
- there should be normal distribution;
- data must be in ratio scale;
- the variables must be two independent categorical groups;

The statistic is given by the formula: t = experimental effect / variability

= difference between group means / standard error of difference between group means

The criterion for determining statistical significance is a "2-tailed significance" less than the alpha value of 0.05. Where the calculated was greater at 5% level of significance, we accepted our hypothesis. The comparison with the table value is also automatically done by the software and the significance level indicated.

UNIVERSITY OF IBADAN

CHAPTER FOUR

THE STUDY AREA

4.1 Location

For the purpose of this study, the northwest region consists of Udoh's (1970) Rima and Middle Niger Valley regions of Nigeria (Figures 4.1). It covers those sections of the Rima and Middle Niger Valleys within Sokoto, Kebbi and Niger States. The Rima region consists of the Sokoto basin (about 57936.50 square kilometres) and that of the Rima basin (about 56327.20 square kilometers) while the Middle Niger valley region starts from Kebbi State in Yauri Emirate down to Ilorin in Kwara State, covering the whole of Kogi State and the FCT. It also covers Niger State north of River Niger excluding Chanchaga Local Government Area. However, our study area lies within Sokoto, Kebbi and Niger States up to Kainji as shown by the map (Figure 4.1).

The figure shows the major cattle transhumance (yellow bold line) route, (which used to be the cattle trade route), the subsidiary routes (represented by thin red lines) and specific locations which are the sample DOTS centres. While the major route follows the road network and is almost in a straight line, the subsidiary routes are winding and twisted, indicating rhythmic movements in respect to local availability of pastures. At various places, the subsidiary routes cross over the major route.

The study focused on a single major transhumance route within the region (as opposed to a multitude of routes), comparing it with other non-migration areas. Our reason was informed by the need to use the route with the highest traffic so as to serve as a reference for all other routes. The routes are numerous, depending on the Fulani nomad or the nature of the migration, but the one with the highest traffic could be identified and studied, which is what we did.

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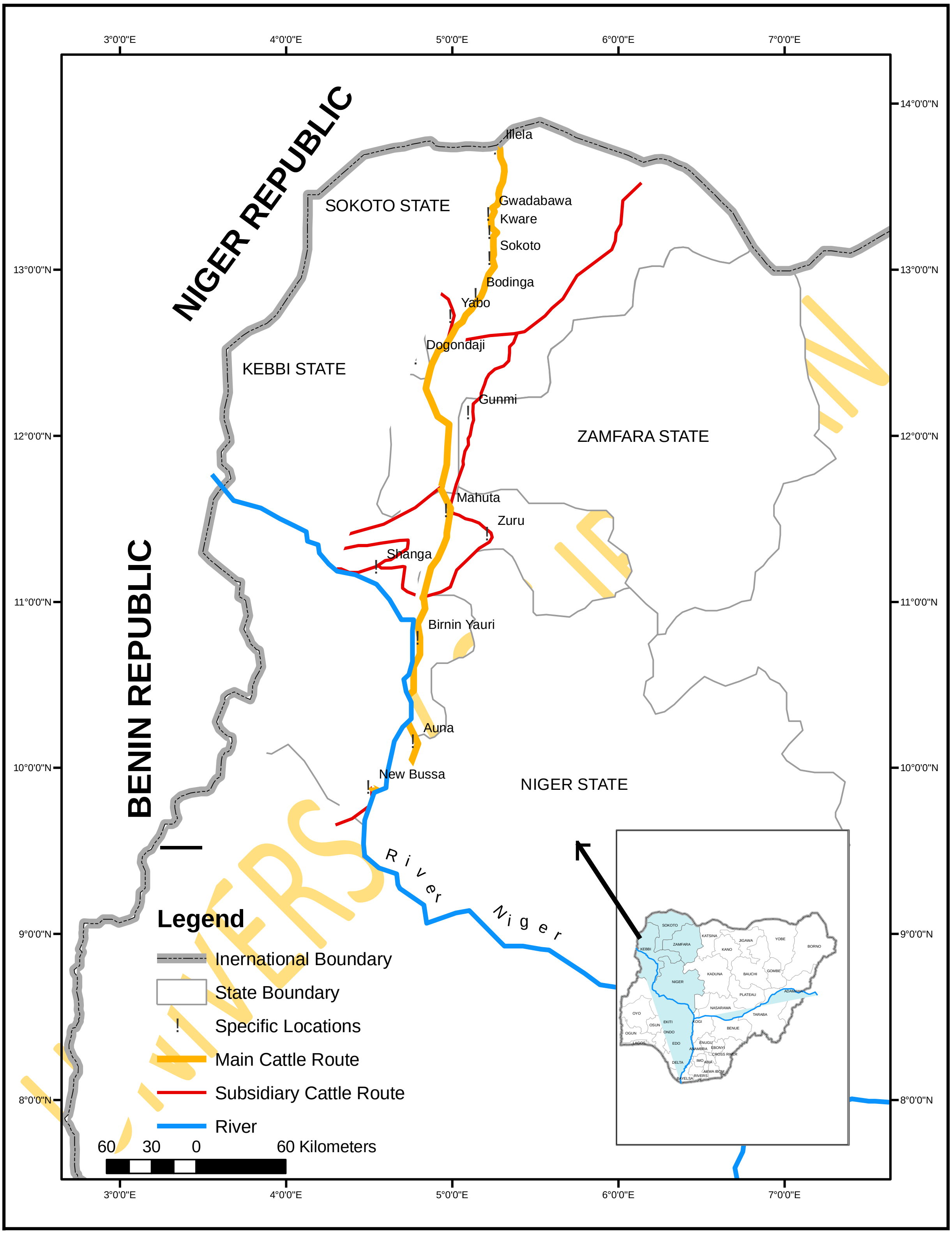

Figure 4.1: Fulani Transhumance Routes in the Study Area

Source: Fieldwork, January 2011

4.2 Physical characteristics

4.2.1 Relief, geology and drainage

As stated earlier, the study area is drained by the rivers Sokoto, Rima and the Niger. There are also smaller tributaries that drain into the Niger, such as the Kontagora or the Sokoto, such as the Bunsuru from Zamfara State. All along these river valleys there are expanses of very wide flood plains (called *fadama*) that are very suitable for dry season crop cultivation because of their clayey loamy soils and water availability all the year round, which also gives reason why the Fulani go along these flood plains during their seasonal migration. The relief is generally low and the geology is sedimentary in the areas around Sokoto and northern parts of Kebbi, but become dominated by the Basement Complex formation along the Middle Niger Valley.

4.2.2 Climate

The Study area falls within the Tropical Continental Climate belt dominated by two opposing air masses; the dry Tropical Continental blowing from the Sahara Desert and a moist Tropical Maritime air mass from the Atlantic Ocean. While the former blows from a north easterly direction, the later comes from a south-westerly direction but vary gradationally as one moves towards the south. These two major air masses result in two major seasons, the wet and dry. Thus at the extreme north, we have a long dry season from October to May and a short rainy season from May to September, but the two seasons almost equalize as one goes towards the Kainji Lake reservoir. In between these two major categories there is the harmattan period with its dry, cold and dusty wind from across the Sahara Desert between November and February, thus reducing visibility sometimes to less than 1000 metres in the far north. During this period, the weather is usually cold at night and in the mornings with temperatures less than 20^{o}C in some cases in the far north.

Mean annual rainfall also varies with the location but is usually between 600mm in the far north to 1000mm towards the south, with a peak in August when almost a third of the annual rainfall is received. Over the last fifty years, the rainy season has been characterized by late arrivals of rains, long spells of aridity of up to 21 days and early cessations. This is suggestive of climate change. Therefore, rainfall, which shows marked seasonality, is the most important critical element of climate in this region. Humidity is all the year low (about 20% in the extreme north) except during the rainy season (July to September) when it reaches up to 60 to 70%. Temperatures are generally high throughout the year reaching about 45^{o}C in May but may drop to about 20^{o}C in December to February during the *harmattan* period. The rainfall of the upper Middle Niger valley has the mean annual value generally deceasing from east to west, the length of the dry season being longer in the upper Middle Niger valley than in areas southwards.

The dry dusty climate in the region is implicated in the high prevalence of tuberculosis. This is because not only is the disease air-borne, but the agents could be retained by the dust in the atmosphere and be carried elsewhere by the winds. Similarly, the long period of dryness could also ensure that the virus remains for a longer period in the air to infect susceptible persons as opposed to what obtains in the southern parts of the country where the rains wash away the agents. These factors, coupled with high poverty level of the people, which the disease is known to capitalize on, could give rise to high prevalence rates of tuberculosis within the region.

4.2.3 Soils and vegetation

The vegetation of the study area is highly gradational, starting with a typical Sudan Savannah at Illela (Sokoto State) at the border with Niger Republic which consists of an almost continuous grass cover and thin tree cover, moving southwards to the Guinea Savannah and Savannah woodland, as well as riparian vegetation along the river valleys and the Kainji Lake Reservoir. Trees in the far north consist of a mixture of fine-leaved thorny trees such as acacias, locust bean, the baobab, tamarind and some broad-leaved species of the Guinea savannah such as Shea butter and *Isobalina doka*. The vegetation of the Middle Niger valley is however transitional and consists of open savannah woodland with a greater density of trees in the south. The *fadamas* of the large rivers support open savannah with occasional trees, but the valleys of the smaller and seasonal streams are covered with dense riparian woodlands. During the early dry season when the vegetation is burnt, the ground first becomes barren and blackened, and almost immediately, the grass begins to sprout.

Soils in the far north are more or less sandy but could be loamy or clayey along the river valleys which make them rich for agricultural production. At the uplands and as

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one moves towards the 'Middle belt', they become more lateritic and poor in nutrients, thus becoming less agriculturally productive. The nature of the soil and the rainfall regimes are therefore major determinants of vegetation types and the availability of pastures for the livestock. This is the more reason why the Fulani keeps migrating seasonally to catch up with water and pasture.

4.3 Socio-economic characteristics

4.3.1 Population

The 2006 National Population Census (NPC, 2006) showed the population of the Study Area to be 14,192,864 people (Kebbi State, 3256541; Zamfara State, 3,278,873; Niger State, 3954774; and Sokoto State, 3702676). These are projected for the year 2010 as 16,461,408 (Kebbi, 3,777,054; Zamfara, 3,702,946; Niger, 4,586,890; and Sokoto, 4,294,498). Population density is generally low in the study area and population is mostly concentrated in the urban areas and in the closed settled zones around the urban areas. The study cuts across sixteen Local Government Areas, though two (Shagari and Sokoto South in Sokoto State) had no DOTS centres at the time of data collection. The centre at Sokoto North covers metropolitan Sokoto that includes Sokoto South Local Government. There are also fifteen (15) Local Government Areas with DOTS centres that served as control. The population figures of the LGAs are presented in Tables 4.1 and 4.2.

As at the time of data collection, population figures were not available for the individual localities. However, projections were made from the 1991 figures, though not for all the identified settlements along the route since smaller settlements and hamlets were lumped together in the 1991 census report. These are presented in Appendix III because of their number.

UNIVERSITY OF IBADAN

Table 4.1: Population Figures of Sample Local Government Areas along the Route

LGA	State	Males	Females	2006 Total	Projected 2010 (at 3.01% Growth Rate)
Bodinga	Sokoto	87,844	86,458	174,302	202,189
Gwadabawa	Sokoto	116,300	155,269	231,569	268,620
Illela	Sokoto	74,949	75,184	150,133	174,154
Kware	Sokoto	66,778	67,306	134,084	155,537
Sokoto North	Sokoto	124,134	108, 878	233.012	270,294
Sokoto South	Sokoto	103,207	94,497	197,686	229,316
Wamakko	Sokoto	91,466	87,780	179,246	207,896
Tambuwal	Sokoto	113,495	112,422	266,197	263,224
Yabo	Sokoto	59,417	55,885	115,302	133,750
Shagari	Sokoto	79,438	77,469	156,907	181,987
Gummi	Zamfara	102,686	104,035	206,721	239,796
Shanga	Kebbi	63,478	63,664	127,142	147,485
Yauri	Kebbi	53,016	47,548	100,564	116,654
Ngaski	Kebbi	62,480	63,622	206,721	146,278
Zuru	Kebbi	86,354	78,981	165,335	191,789
Wasagu/Danko	Kebbi	131,388	133,883	265,271	307,641
Agwara	Niger	29,293	28,054	57,347	66,523
Borgu	Niger	87,327	85,504	172,831	200,484

Source: NPC, 2006 and Fieldwork 2011

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Table 4.2: Population Figures of Control Local Government Areas

LGA	State	Male	Female	2006 Total	Projected 2010 (at 3.01% Growth Rate)
Aleiro	Kebbi	34368	32710	67078	77810
Argungu	Kebbi	99658	100590	200248	232288
Dandi	Kebbi	72907	73304	146211	169605
Gwandu	Kebbi	74610	76467	151077	175249
Jega	Kebbi	98936	98821	197757	229398
Maiyama	Kebbi	85728	88031	173759	201560
Binji	Sokoto	52949	51325	104274	120958
Ange-Shuni	Sokoto	97709	95734	193443	224394
Gada	Sokoto	122232	126819	249051	288899
Goronyo	Sokoto	90639	91479	182118	211257
Rabah	Sokoto	75001	74151	149152	173016
Silame	Sokoto	53091	51510	104601	121337
Tangaza	Sokoto	55309	59461	114770	133133
Tureta	Sokoto	34567	33847	68414	79360
Wurno	Sokoto	81854	80549	162403	188387

Source: NPC, 2006 and Fieldwork, 2011

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The States within which the study area falls (Sokoto, Kebbi, Zamfara and Niger) used to belong to two Provinces (Sokoto and Niger) later merged as a single State, until 1976 when they were separated into Niger and Sokoto States. Kebbi State was also created out of Sokoto State in 1991 and later Zamfara in 1996.

4.3.2 Ethnicity and religion

The majority of the people in the region are Muslims but the proportion of those of Christian faith and traditionalists increases as you move southwards towards Kainji. There are also a number of ethnic groups within the region, but the Hausa-Fulani dominate. In the far north, we have the Hausa-Fulani and Zabarmawa. As you move southwards, the Kambari, Dakakari, Gwagi and Nupe dominate. There are thus people of varied cultures and religious beliefs across the entire region.

4.3.3 Agriculture and livestock

The primary activity of the people within the region is agriculture with variations depending on the location. Livestock raising and grain cultivation are common in the far north, particularly by the Hausa- Fulani while maize and tuber crops assume prominence southwards. Along the river valleys, there is extensive cultivation of rice and condiments, such as onions and peppers in the far north, particularly during the dry season as well as some fishing activities.

Cattle are kept for meat, milk, butter and manure for both subsistence and commercial farming, while the ruminants are kept for meat and manure only. Cattle milk could be taken fresh, but in most cases it is consumed as yoghurt (*nono*) with *fura* (millet drink) when kept overnight .Plate 4.2 shows nomadic Fulani women selling *nono* and cow butter at Chipamini in Warra Local Government of Kebbi State. The cattle dung is used directly on farms as manure by the livestock owners or it could be sold to other farmers, or could even be given in exchange for crop residues. In fact, livestock keeping is an important household economic activity that provides income and satisfies daily needs. It also signifies the wealth status of the individual within the Fulani community.

Cattle are mostly kept by the Fulani, together with few ruminants that cater for immediate or emergency needs during festivities and provide medications. However,

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the Hausas have nowadays learnt to keep some cattle in their houses for their daily needs of dairy by-products, particularly *nono* and butter in the absence of the Fulani as well as for the purpose of fattening of the animal prior to their sale. In fact, *nono* is consumed with *fura* in every household in the northern most part of the study area, i.e. Sokoto, Kebbi and Zamfara. The quantity of *nono* (unpasteurized milk) consumed by the people in this area and the amount of manure generated by the livestock could have implications for tuberculosis infection and spread. This could be so because the disease is both air-borne and zoonotic, and the environment is dry and dusty during the Harmattan period; a condition that promotes air-borne diseases generally.

The average size of the flock (both cattle and ruminants) could vary depending on ownership, but in most cases it ranges between two hundred and one thousand. The migrating flock may not be more than five hundred due to the difficulty of controlling the animals while on transit, but the Fulani may add to the number annually from the home reserve if he decides not to make a return journey that year or if the pasture situation at home gets worse.

4.3.4 Characteristics of the Fulani

Livestock rearing is the main occupation of the Fulani (Plate 4.1), but the Fulani does some arable farming or trading activities when opportunities arise. The men find grazing sites, go on long distance transhumance and construct the camps whilst the women and children do the milking of cows and selling of the milk and its by-products. Plate 4.2 shows Fulani women selling *nono* and *man shanu* (cow buter) while Plate 4.3 shows a typical Fulani camp.

A typical nomadic Fulani engages in extensive seasonal pastoral movements dictated mostly by the seasonal availability of pastures and water. Nowadays, he also moves to avoid insect pests, livestock thieves and hostile social environments. Having been in the business for years, he has ample knowledge of the seasonal and grazing conditions of the areas he used to visit and therefore knows where to move to during the year. However, only a few of the Fulani are itinerants nowadays, merely erecting temporary shelters along their routes (Plate 4.3). The majority have permanent homes to which they return yearly during the resting season (Stenning, 1959). The population of the pure Fulani nomads has been estimated at 5.3 million (ADEA, 2005). Most of the

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nomadic pastoralists from the study area come from Sokoto, Kebbi and Zamfara States. There could also be other pastoralists that rear sheep and goats called *Udawa* from the Republic of Niger. Discussion with some nomads revealed that seasonal migration follows definite routes which could be identified and monitored. There are also nationally-marked (or official) routes, which may or may not be followed by the Fulani during the course of their movement.

Nomadic Fulani pastoralists are geographically and socially marginalized, inhabiting large regions devoid of infrastructural development due to their mobile lifestyle. In fact, they are found in all States of the federation. Their lifestyle allows them access to only the rural clinics and dispensaries, if any. More often than not, patent medicine stores are patronized such that only the most serious medical problems are looked into at urban hospitals.

4.3.5 Fulani seasonal migration

Depending on the climatic situation and the location, the end of the wet-season and the beginning of the dry-season may set in between October and December in the areas of origin. This is the period when the Fulani begin their southward migration. March and April are the hottest months and the Fulani are in their southernmost locations. May to June is the end of the hot season and the beginning of the rainy season when the Fulani start moving northward, determined by the rate of reappearance of the grass. June to September is the peak of the rainy-season and the Fulani reach their northernmost homes in July. These movement schedules could however vary with the Fulani group. While some start migrating at the end of the rainy season, others migrate at the peak of the season so as to have continuous pasture for their livestock throughout the year. Still, others move only when the situation becomes critical.

Movement could start from the areas of origin in the far north (Wamakko, Yabo, Silame, etc) in the month of December, taking about one week to reach stop-over places such as Gayari (Gumi LGA, Kebbi State), Jabo (Tambawal LGA, Sokoto State), Gambanda (Gumi LGA, Zamfara State) and their environs where the pastoralists spend a few days or months before moving southwards. The second migratory route also from the same areas of origin consists of a southwards movement

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immediately after rains (during harvesting period) to similar destinations but this time through Yauri (Kebbi State) and goes on without any major stop-over until the nomads reach Mokwa (Niger State). There could also be other variants that spread out from these routes through other locations, but later converging at the same destinations. Therefore, the seasonal livestock carrying capacity of the land determines the latitudinal location and the extent of dispersion or congregation of the Fulani. Since each group knows the location it is seasonally heading to, the study locations (origins, stop-over and destination areas) can easily be identified. The patterns are, according to the *Ardos* at Dogondaji and Yabo, illustrated in Figure 3.1 (page 46).

The areas of origin are located within the Sudan vegetation zone and to some extent Sahel savannah. These areas are characterized by a well-pronounced dry season during which pastures become inadequate for the Fulani to graze their animals. Water for the animals also becomes increasingly inadequate as the dry season sets in. These are the driving forces that push the Fulani to migrate southwards with their livestock annually in search of pastures and water for their animals. For these reasons, movement takes place along the fadama areas where these resources are available until the Fulani reaches his destination. For those with larger flocks that fear early unavailability of these resources, movement takes place immediately after crop harvesting, but for those with small stocks and a reserve of crop residues, movement takes place when the reserves are about to get exhusted.

The stop-over places are mainly areas along the Rima and Niger River valleys and their tributaries. These are also more often than not mid-way to the destinations. As at the time the Fulani reaches these places, pastures and crop residues for his livestock are still luxuriant and in abundance because the rains have either not ceased or the grasses have not been tempered with. For this reason, he spends ample time to exhaust the available pastures before he proceeds. A place like Gayari, where calabash residues are available immediately after crop harvesting, is noted as a prominent stop-over place. Around Lake Kainji also, Warra, Chipamini, Auna, Sabon Auru, Tsohon Auru and Dutsen Gogo and their environs are prominent places. More often than not, these stop-over places are also in areas of virgin lands of forest/game reserves such as the Borgu Game Reserve. Even though grazing and hunting are prohibited in these

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areas, the Fulani still insists on grazing his animals. There are however other stop-over places that the Fulani stops to either have some rest of buy food and medical items. New Bussa is one of such places where the Fulani buys all his drugs before proceeding into the bush with his livestock for days or months. Figure 3.2 is a flow diagram of the routes followed by the Fulani and the various origins, stop-over and destination places, indicating his duration of stay around the area.

The destination areas are places that the Fulani spends ample time (usually months) before making a return journey back home. These are located in areas where pastures and surface water for watering of livestock are available throughout the year because of the availability of rains almost all year round. The vegetation is also always luxuriant, which also helps to breed tsetse flies. Some of these places are in the far south such as Shaki in Oyo State and Kiama in Kogi State, while others are still within the middle belt where the Fulani finds sufficient pasture to stay throughout the year such as Borgu Forest in Niger State. Destinations are therefore determined mostly by the livestock carrying capacity of a particular place. Because of tsetse flies that transmit trypanosomiasis, the Fulani always tries to make a return journey back home immediately pastures become available there. Therefore, movement could be driven by a number of factors such as availability of pasture and water or lack of them, pests and diseases, as well as thieves.

In all places, the Fulani do not live in the towns and villages. Rather, they erect their huts using sticks and grasses outside settlements where their animals find pasture and comfort. Plate 4.1 shows a typical cattle grazing site while Plate 4.3 shows a typical Fulani camp. Plate 4.2 also shows a typical Fulani market where unpasteurized milk is sold by Fulani women. The animals are kept around the camps becauses of thieves and other carnivorous intruders. Thus, the Fulani sleeps in the midst of his animals, while his wife and children sleep in the hut. Drinking water is fetched by the women and children and kept in pots inside or beside the hut. This water may however not be potable since, more often than not, it is fetched from the watering points of the animals which is also used for other domestic washings. Therefore, the sanitary conditions within which the Fulani live cannot be said to be good since they live in the midst of animals and dung, mosquito-prone environments, poor quality water and above all insecurity of their lives and property. Their diet could also not be said to be

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balanced, even with the milk intake, since their daily activities require a lot of energy-giving foods such as cereals which are obtained only when they stop-over at some places or when their women go to sell *nono* and cow butter. These conditions could make the Fulani vulnerable to a number of diseases such as tuberculosis and thus promote its incidence and spread.

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Plate 4.1: Fulani Livestock Grazing on the Fields

Source: Fieldwork, September 2011

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Plate 4.2: Fulani Women Selling Unpasteurized Milk and its By-products
Source: Fieldwork, January 2011

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Plate 4.3: A Typical Fulani Camp

Source: Fieldwork, January 2011

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CHAPTER FIVE

SPATIO-TEMPORAL ANALYSIS OF TUBERCULOSIS PREVALENCE

Introduction

This Chapter examines the spatio-temporal pattern of the prevalence of tuberculosis among the sample DOTS centres (Table 5.1) as well as origins of patients to DOTS centres (Appendix II). A comparison is made between the sample DOTS centres (Table 5.1) and the control DOTS centres (Table 5.2). The sample DOTS centres are proximate to the migration routes, while the controls represent DOTS centres located away from the migration routes. The chapter looks at the monthly and seasonal (temporal) variations for all the stations combined as well as for each of the stations. It also considers spatial variations in the different stations. The Microsoft Excel was used to produce graphs, while Analysis of Variance (ANOVA) and Test of Mean Difference (t- test) were used to test the significance of these variations.

5.1 Temporal variations

5.1.1 Sample DOTS centres

Monthly variations in the prevalence of tuberculosis between sample DOTS centres are presented in Table 5.1. The table shows that the monthly tuberculosis prevalence totals for all the stations do not vary much, except for the month of August that has 89. December has the highest prevalence with 168 and August has the lowest with 89. The months of April (122), May (122) and June (121) seem to have similar prevalence. Therefore, except for the months of September and October (which seem to tally with the months of December, January and February), slightly lower prevalences are recorded in March to August. We could recall that the month of August is the peak of the rainy season in the far north, which may have assisted in washing away the harmatan dust that perhaps hosted some of the pathogens in air. The high temperatures combined with low humidity in March, up to the onset of the rainy season in May/June, could also have contributed in killing some of the tubercules in the air.

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Table 5.1: Monthly Prevalence of TB in the Sample DOTS Centres in 2010

Health Facility (DOTS Centre)	**Month of the Year**												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
GH ILLELA	12	7	10	9	5	7	8	2	15	23	8	9	115
PHC GWADABAWA	7	4	12	4	8	10	6	9	11	6	8	8	93
CHC KWARE	8	3	1	3	8	7	4	2	9	2	11	21	78
SH SOKOTO	38	52	67	29	29	37	48	9	45	54	35	41	484
GH BODINGA	1	1	5	7	8	2	0	7	13	7	5	6	59
GH YABO	3	3	1	3	2	2	3	3	4	3	4	2	34
GH DOGONDAJI	1	2	3	2	1	3	1	2	1	5	6	3	30
GH GUMMI	5	7	1	4	0	2	2	1	5	2	2	3	34
MBGH ZURU	16	27	10	12	20	18	6	12	18	18	9	16	182
PHC MAHUTA	9	4	6	1	3	2	1	5	1	4	1	3	40
GH SHANGA	12	6	4	13	6	5	7	3	5	6	4	5	76
GH YAURI	21	26	32	23	22	14	29	18	13	18	18	25	259
GH WARRAH	7	5	2	3	2	4	4	5	4	6	8	16	66
RH AUNA	2	3	0	1	1	1	0	2	1	2	1	3	17
GH NEW BUSSA	8	3	9	8	7	7	9	8	8	10	4	7	88
TOTAL	150	151	143	122	122	121	144	89	153	166	133	168	1655

Source: Fieldwork, July-September 2010

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The lowest prevalences were recorded in August for Sokoto, Illela, Gummi and Shanga DOTS centres, which is the period of highest rainfall, while the highest prevalences were recorded in March for Sokoto, Gwadabawa and Yauri DOTS centres, which also coincide with the period just before the onset of the rainy season when rains might have cleansed the atmosphere of the tubercules. This is also the period of high tempretures that might have promoted the multiplication of the disease agents. This relationship which is again shown in Figure 5.1 portrays an ascending trend from January to December. Thus, this further reinforced the roles of the Harmattan dust and high temperatures combined with low humidities before the onset of the rainy season. To show the pattern in the individual stations, Figures 5.2a to 5.2n. Figure 5.1 were plotted.

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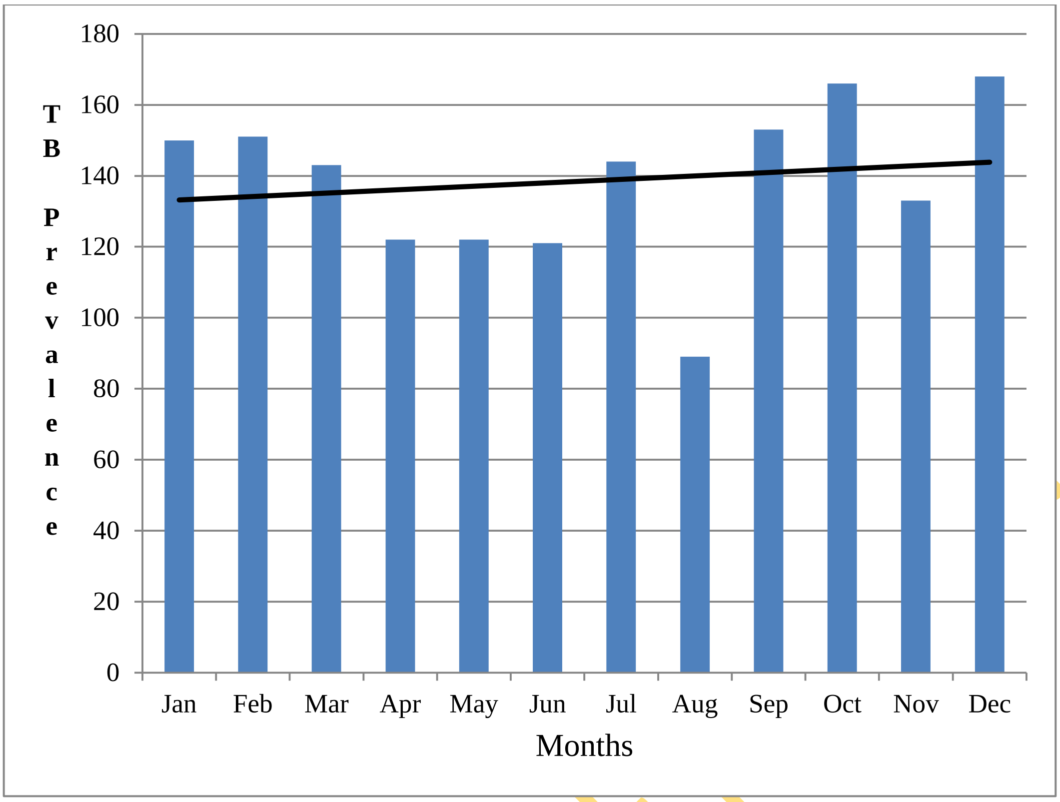

Figure 5.1: Temporal Variation of Tuberculosis Prevalence of all Sample DOTS Centres in 2010

Source: Fieldwork, January 2011

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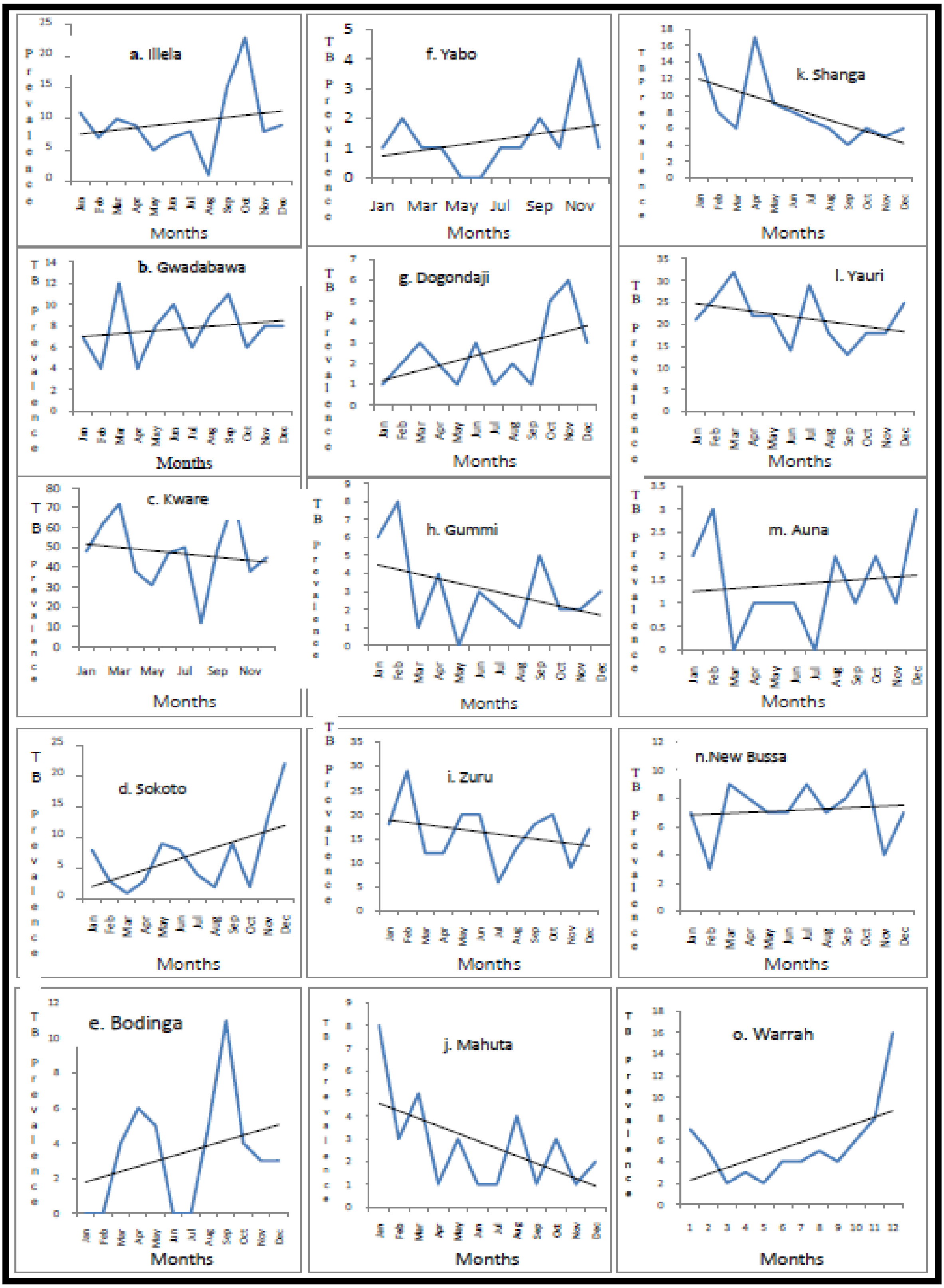

Figure 5.2: Temporal Variation of TB Prevalence at Various Sample DOTS Centre in 2010

Source: Fieldwork, January 2011

In Figures 5.2 (for Illela, Gwadabawa, Kware, Bodinga, Yabo, Bodinga, Auna and New Bussa DOTS centres), tuberculosis prevalence show upward trends between January and August and rises again with the highest peak in the month of October. The rest of the stations (Sokoto, Gummi, Zuru,, Mahuta, Shanga and Yauri) show a downward trend in the prevalence. Sokoto, Gummi, Zuru,, Mahuta, Shanga and Yauri however generally show higher prevalence than the rest of the stations. Interestingly, all stations with an upward trend generally show high prevalence from October to December. Similarly, those with descending trends generally show high prevalence in the months of January to March. October to December is the harvest season in the far north and the period the Fulani start to move southwards. Similarly, January to March is the period when the Fulani start to move northwards. The question is, could the presence of the Fulani in any of these places have influenced the prevalence of tuberculosis or could it simply be a coincidence?

If we agree that the latency period of the disease is at least four months, then it is logical to premise that the presence of Fulani in those places could have influenced the availability of unpasteurized milk and its by-products apart from climatic factors, and invariably, the prevalence of tuberculosis. The question that still remains unanswered is, can we account for the number of people that take these by-products (*fura da nono*) in view of the fact that people from these places differ in their socio-economic characteristics? Could we also solely attribute the higher prevalence to consumption of unpasteurized milk and its by-products in the drier environments that are dusty at certain periods of the year? We may need to find out the number of the patients that come from rural settings (where *fura da nono* is a staple food) in order to ascertain the effects of other causative factors. Certainly, answers to these questions can only be provided when all the risk factors and the socio-economic correlates are examined but obviously, characteristics of different locations do play some role in the pattern.

Another point of interest is also the fact that places in the far north (excepting for Gwadabawa and Sokoto DOTS centres), record their highest prevalence during the months of September to December. October is the month when the dry season begins in this part of the region and August is the peak of the rainy season and the breeding period when the Fulani are settled in the northern most part of the region. If the

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higher prevalence is recorded just before the Fulani start migrating, it shows that the presence of Fulani in the area during the rainy season could have influenced the availability of unpasteurized milk and invariably, the prevalence of tuberculosis since the disease could remain in asymptomatic form for at least four months before it manifests itself. Mitsos *et al*. (2003) have rightly observed that only a small proportion of individuals infected with *M. tuberculosis* develop the clinical form of tuberculosis. However, clinical determination has to be made in order to ascertain the type of tuberculosis before attributing consumption of unpasteurized milk to it.

Mahuta, Zuru, Shanga, Gummi and Yauri, as stop-over places, show high prevalence during the months of January to April, with some minor variations among stations. This also means that if the Fulani were in those places between November and December, their presence could have influenced the availability of milk and its by-products and perhaps, the prevalence of tuberculosis, for the same reason stated above. The possibility of consumption of unpasteurized milk or its by-products as the causative agent of the prevalence of tuberculosis cannot therefore be ruled out.

New Bussa, which is a destination area, has an almost uniform trend with the prevalence descending only in the months of February and November. November to February are the months of arrival in this area and one does not expect to have high prevalence due to consumption of milk or its by-products during this period. It has to take some time before the Fulani get settled and make these by-products available, and the manifestation of tuberculosis will also have to take some months. An almost parallel trend or uniform prevalence from March to December is an indication that the influence starts to manifest three to four months after the Fulani arrival and continues up to the time when they start to migrate northwards. It is therefore logical to believe that the presence of Fulani in the destination areas must have influenced the availability of fresh milk or its by-products and may be a factor in the prevalence of tuberculosis.

Gwadabawa, which appears to be a buffer zone between the *Rahaje* (or *Jajaye)* and the *Gudale* cattle zones, and the starting point of most migrant Fulani, also shows an almost parallel trend in the prevalence. It has been observed that minimal transhumance takes place between Illela and Gwadabawa as attested by the type of

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cattle that migrate. From Illela to Gwadabawa we have the red cattle (or *Rahaje* or *Jajaye*), which are rarely seen migrating. From Gwadabawa down south, we have the white *Gudale* cattle which are involved in the migration. This area is therefore a buffer zone and a starting point (place of origin) of Fulani migration. The parallel trend may be an indication of the continuous availability of fresh milk and its by-products all year round in this area, which might have been manifested by an almost continuous prevalence of tuberculosis in the area throughout the year. It is therefore logical to premise that the year round presence of the *Jajaye* cattle could have been responsible for the trend in the prevalence of tuberculosis. In all cases however, caution needs to be exercised in solely attributing the prevalence to unpasteurized milk and its by-products since the way a disease is transmitted is a function of so many factors that may even act collinearly.

Linear trendlines fitted on graphs (Figure 5.2) using the linear regression equation also showed steep upward trends for Sokoto, Bodinga, Yabo and Gwadabawa stations, and steep downward trends for Zuru, Mahuta and Shanga stations, indicating linear positive and negative relationships respectively. In other words, prevalence increases from January to December for Sokoto, Bodinga, Yabo and Gwadabawa stations, while it is the reverse for Zuru, Mahuta and Shanga stations. As for the other stations, the trendline appears to flatten out. Thus, there is no area-wide seasonal trend in the prevalence of tuberculosis in the study area. An interesting feature to note here however is that stations with steep upward trends are located in the far north (areas of origin) where the environment is more arid and less vegetated, while those with steep downward trends are located in less arid and more vegetated environments mid-way to areas of destination. It is probable that increasing aridity, which is associated with less moisture, dusty condition and sparse vegetation, could be promoting the prevalence while the reverse of these conditions inhibits the promotion. Invariably, it appears that climate may be playing a role in affecting temporal variation of tuberculosis prevalence indirectly by affecting the etiology of the disease or exposure of individuals to it, or perhaps the transmission process. To substantiate this however, data on rainfall and other climatic conditions, as well as vegetation cover for the different areas need to be correlated with tuberculosis prevalence, which is beyond the scope of this work.

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The significance of the differences in the temporal pattern between stations along the migration route was tested using the Analysis of Variance (ANOVA). The results are presented in Table 5.2. These show no significant difference between the months of the year, F (11,168) = 0.319, p=0.981 since the p-value is greater than 0.05. Thus, monthly variations are not important in the prevalence of tuberculosis in the study area. The *Between Group Variation* is also significantly lower than the *Within Group Variation*, thus again implying lack of statistical significant difference between the months. The assertion that tuberculosis prevalence varies temporally along the route of migration is therefore refuted.

Temporal variations were further examined by merging the monthly figures to seasons (dry and wet) as shown in Table 5.3. The table shows a higher prevalence record for the dry season than the wet season, indicating that seasonality plays a role in the prevalence. In particular, Sokoto (262) and Yauri (145) DOTS centres have the highest prevalence while Auna (10), Yabo (16) and Dogondaji (17) DOTS centres have the lowest. A similar pattern is also observed during the dry season. However, the prevalence is generally higher for all stations during the dry season than the wet season, with the exception of New Bussa, Illela, Gwadabawa, Bodinga, Yabo and Zuru DOTS centres that show slight increases. The higher prevalence in New Bussa during the wet season could be explained by the higher concentration of cattle at that end during the period while higher prevalence in Sokoto, Yauri and the rest of the stations could also be explained by the climatic conditions (dry and dusty) that promote the spread of the pathogen in those places. Whatever the case might be, season of the year and concentration of cattle in a particular place could play a role in the prevalence.

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Table 5.2: The Results of the Analysis of Variance for Sample DOTS Centres During the Months

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	443.013	11	40.274	.319	.981
Within Groups	21196.964	168	126.172		
Total	21639.978	179			

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Table 5.3: Seasonal Values of TB Prevalence at Sample DOTS Centres in 2010

Health Facility	Dry Season (Nov-April)	Wet Season (May-Oct)	Total Prevalence
GH Illela	55	60	115
PHC Gwadabawa	43	50	93
CHC Kware	47	32	78
SH Sokoto	262	222	484
GH Bodinga	25	37	59
GH Yabo	16	17	34
GH Dogondaji	17	13	30
GH Gummi	22	12	34
MBGH Zuru	90	92	182
PHC Mahuta	24	16	40
GH Shanga	44	32	76
GH Yauri	145	114	259
GH Warra	41	25	66
RH Auna	10	7	17
GH New Bussa	39	49	88
Total	880	778	1655

Source: Fieldwork, Januaey, 2011

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The mean difference between seasons was tested using the Student's t-test. The t-test results (Table 5.4) indicate no statistically significant difference among the seasons (t=1.798; p=0.094) in the prevalence of tuberculosis in the study area since the p-value is greater than 0.05 under 14 degrees of freedom. This does not support the higher prevalences during the dry season than the wet season, which also means seasonality is not important in the prevalence of TB in the study area. Some other factors to be considered in the preeding chapters may explain the situation.

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Table 5.4: The Results of the t-test for Seasonality at Sample DOTS Centres

Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
6.80000	14.64923	3.78242	-1.31247	14.91247	1.798	14	0.094

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5.1.2 Control DOTS centres

Monthly variation in the prevalence of tuberculosis among the control DOTS centres is presented in Table 5.5. Looking at the individual stations, there appears to be no obvious variation between the months during the year, except for the month of May. While Aleiro, Amanawa, Binji, and Gada have their highest prevalence records in December, this is the period when the dry dusty Harmattan sets in. Even though temperatures could be low, the dust in the atmosphere could have helped to retain the tubercules, in addition to the late manifestation of the latent tuberculosis that may have perhaps been acquired during the availability of unpasteurized milk in the rainy season. Other stations like Argungu and Kamba have theirs in March. Argungu and Kamba are located at the extreme north boardering with Niger Republic, and thus more arid than the rest of the stations. thus, the influence of climate is manifest in these stations.

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Table 5.5: Monthly Prevalence of TB at Control DOTS Centres in 2010

S/No	Health Facility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	GH Jega	13	11	11	14	6	8	6	8	7	7	14	10	116
2	GH Aleiro	14	21	11	4	9	21	8	16	15	10	15	22	166
3	GH Argungu	26	26	38	22	17	15	20	19	15	20	13	9	240
4	GH Gwandu	19	8	15	13	6	9	14	8	13	5	17	5	132
5	GH Kamba	22	37	32	7	13	13	14	8	6	7	5	8	133
6	GH Maiyama	7	3	3	2	2	3	4	5	3	2	3	4	41
7	GH Tureta	6	0	0	0	2	1	3	1	1	1	2	1	18
8	GH Tangaza	0	1	6	4	2	1	3	2	3	3	0	1	26
9	Leprosarium	6	5	14	4	3	6	12	2	13	9	2	15	91
10	GH Wurno	10	10	14	16	17	7	21	11	10	5	11	15	147
11	GH Rabah	18	6	1	2	2	11	8	2	0	6	12	13	81
12	PHC Gande	3	6	2	4	4	5	1	2	3	0	4	2	35
13	GH Goronyo	9	7	5	3	1	4	6	1	2	2	1	5	46
14	GH Binji	1	4	1	1	2	6	5	7	7	1	1	12	48
15	GH Gada	4	0	5	6	1	6	4	7	7	6	4	8	58
	Total	158	145	158	102	87	116	129	99	105	84	104	140	

Source: Fieldwork, January 2011

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Looking at the total prevalene for all the stations, the highest prevalence records are in January and March, while the least records are in May. From December back to January, February and March, one observes the highest prevalence records. December back to March as the dry season period in the region when Harmattan (cold and dry dusty preiod) sets in and later gives way to the hot (also dry and dusty) period just before the onset of the rains. This transitional period, because of the mix between the cold and hot temperatures, coupled with its dryness and dusty nature, could have contributed to the high prevalence of the disease. This trend is shown in Figure 5.3. Generally, high temperatures combined with low humidity promote the incidence of the disease. The fact that this is the period when the Fulani have either migrated or are migrating southwards questions the assertion that availability of unpasteurized milk could have influenced the prevalence of tuberculosis in the area. The drop in prevalence in May could be attributed to the onset of the rainy season which could have cleansed the atmosphere of the pathogens. In other words, tuberculosis prevalence in these stations could simply be attributed to climatic conditions in addition to other hidden factors, rather than the availability of unpasteurized milk.

Figure 5.3 also shows the temporal pattern in the prevalence of tuberculosis for all the control stations. There is a general downward trend from January to December as indicated by the linear trend line, eventhough December still remains one of the months with the highest prevalence records. Interestingly, Kamba which is farthest away from the route of Fulani migration, records the highest prevalence between February and March. This period is the driest and the hottest, just before the onset of the rainy season. Added to this, the station is the nearest to the Sahara desert and therefore all things being equal, drier than the rest of the stations.

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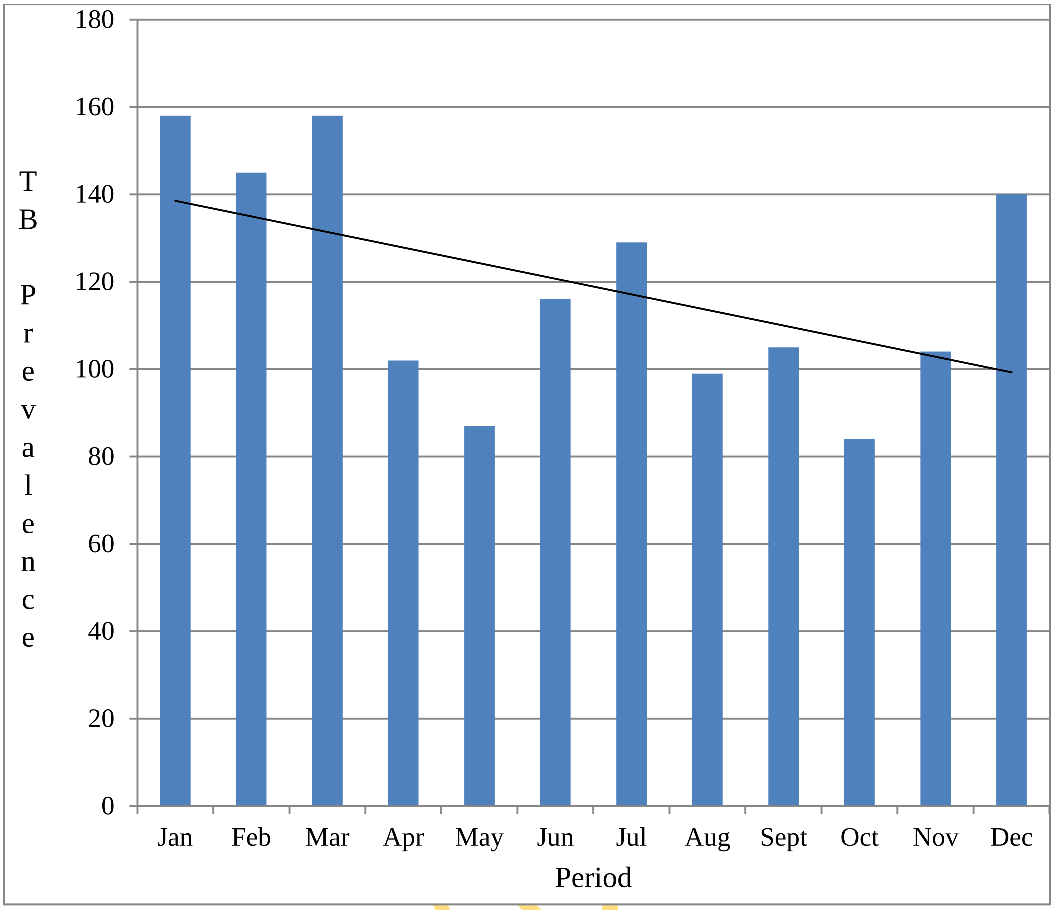

Figure 5.3: Temporal Variation of TB Prevalence at all the Control DOTS Centres in 2010

Source: Fieldwork, January 2011

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Further examination of the variations between seasons was carried out (Table 5.6). This also indicates that the dry season has higher record of tuberculosis prevalence than the wet season, except for Tureta, Tangaza, Binji and Gada DOTS centres that show slight decrease in the prevalence. For these reasons, the high tuberculosis prevalene during the period may be implicated by climatic conditions. The drop in the prevalence in May could be attributed to washing away of the pathogens in the air at the beginning of the rainy season, particularly with the increasing amount of rains by August, when prevalence starts to drop up to December.

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Table 5.6: Seasonality of TB Prevalence at Control DOTS Centres in 2010

Health Facility	Dry Season (N0v – April)	Wet Season (May- Oct)
GH Jega	73	42
GH Aleiro	87	79
GH Argungu	134	106
GH Gwandu	77	55
GH Kamba	111	48
GH Maiyama	22	19
GH Tureta	9	9
GH Tangaza	10	14
Leprosarium	46	45
GH Wurno	76	71
GH Rabah	52	29
PHC Gande	21	15
GH Goronyo	30	16
GH Binji	20	28
GH Gada	27	31
Total	**795**	**607**

Source: Fieldwork, January 2011

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This is an indication that aridity plays a role in the prevalence of tuberculosis, regardless of location. As for Tureta, Tangaza, Binji and Gada DOTS centres, some other factors than climate could be responsible for the drop in the prevalence during the dry season. These patterns are depicted for individual stations in Figure 5.4.

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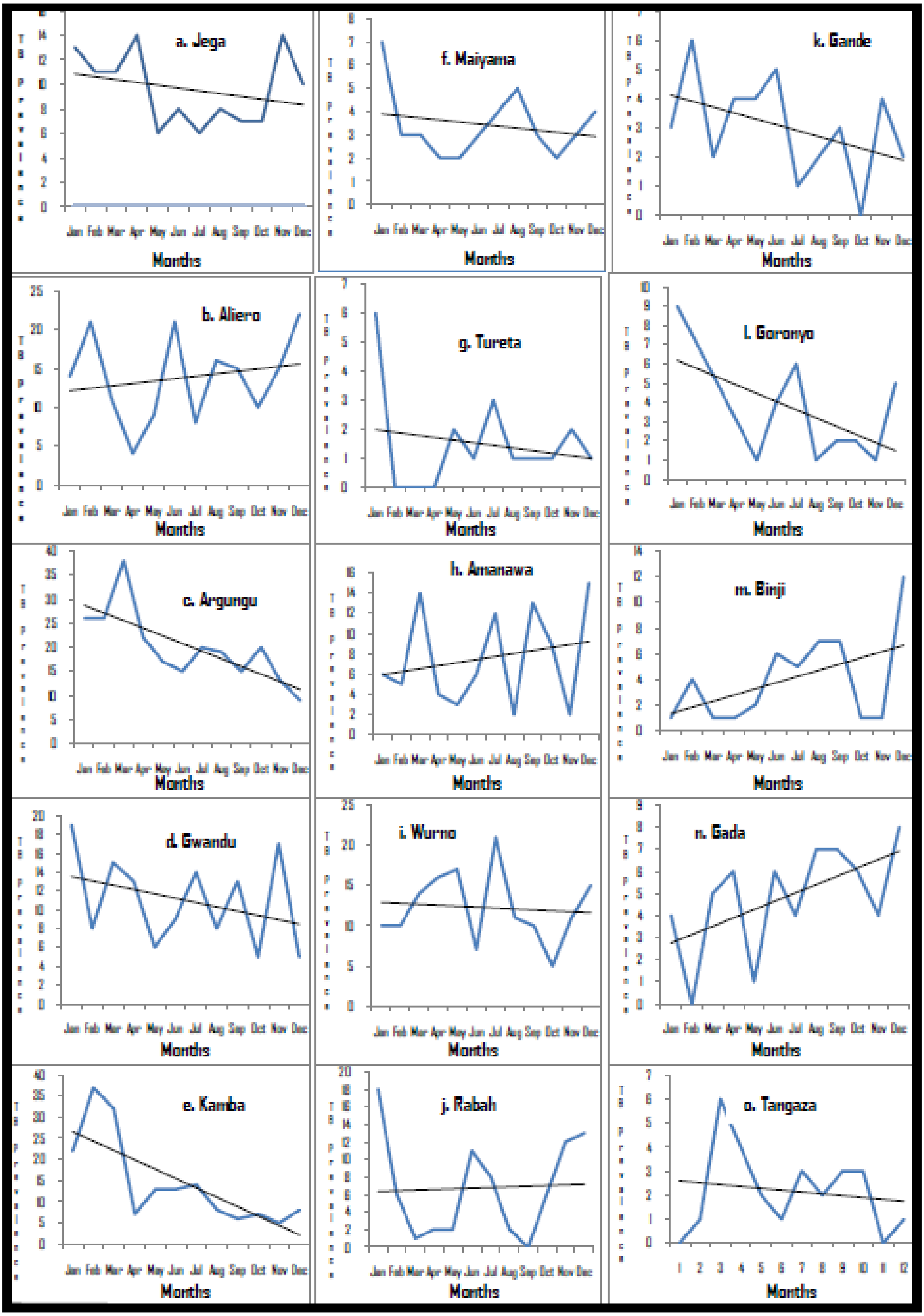

Figure 5.4: Temporal Variation of TB Prevalence at Control DOTS Centre in 2010

Source: Fieldwork, January 2011

It can be argued that although the study is yet to implicate availability of unpasteurized milk as affecting the prevalence of TB in the study area, seasonality is important as evidenced in the temporal variations of the disease. Factors related to seasons may be responsible for the variations. These could be climatic (which this study was not set to investgate), availability of unpasteurized milk and its by-products or perhaps the presence of Fulani and their livestock as carriers. The coming chapters may provide answers to this observation.

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Determination of monthly variations among control stations using a One-Way Analysis of Variance (ANOVA) indicated a statistically significant difference in the means of the variables considered, F (26,153) = 2.064, p = 0.004 (Table 5.7). This shows that the month of the year matters in affecting tuberculosis prevalence among control DOTS stations, in contrast to what was observed in sample stations. As observed earlier, highest prevalences are recorded in the months of Jsnuary, February and March, which are incidently during the dry season, whilst the least prevalences are recorded in May, just at the onset of the rains in the far north. In this situation also, it is probable that the onset of the rains might have cleansed the atmosphere of the pathogens, thereby reducing the prevalence.

Further testing of the significance of the seasons using the Student's t-test showed a statistically significant difference in the means of the two seasons since the (t=2.622; p=0.020) p-value is less than the alpha value at 0.05 significance level under 29 degrees of freedom (Table 5.8). This finding reinforces the role of seasonality in affecting the prevalence of tuberculosis among the control DOTS centres in the study area. The fact that highest prevalences are recorded during the dry season is a testimony that either the atmosphere is cleansed of these pathogens or the climatic conditions are unfavourable for the survival of the pathogens.

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Table 5.7: The Results of the Analysis of Variance for Temporal Variations of Control DOTS Centres

Treatment					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2036.311	26	78.320	2.064	.004
Within Groups	5806.467	153	37.951		
Total	7842.778	179			

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Table 5.8: The Results of the t-test on Seasonality of TB Prevalence among Control (DOTS) Centres

Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
1.25333E1	18.51203	4.77979	2.28171	22.78495	2.622	14	0.020

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5.1.3 Sample versus Control DOTS centres

From Figures 5.1 and 5.3, it is obvious that the highest prevalence for the sample stations are recorded in the months of September, October and December, with intermediate levels of prevalence in January, February, July and March, while January, February and March are the highest for the control stations with December also showing an intermediate prevalence level. For the two types of stations, prevalence for the month of July is similar. Generally however, the linear trend lines indicate an upward trend in the case of sample stations and a downward trend in the case of control stations. The expalanation could be that even though we might not directly attribute the prevalence to Fulani migration and the availability of unpasteurized milk due to lack of significant variations in the monthly prevalence, some other factor could be implicated as indicated by the trend lines. Perhaps explanations could be found among the socio-economic or behavioural factors to be discussed in the forthcoming sections.

Looking at the seasons for the two types of stations (Tables 5.3 and 5.6), a similar pattern was also observed. That is to say, higher prevalences were recorded during the dry season and lower prevalences during the wet season. However, the lack of statistical significance of the variations among the sample stations during the months, is at variance with that of control stations where these variations are statistically significant as indicated by both the ANOVA and the t-test. This goes to show that proximity to route of migration (and invariably the availability of unpasteurized milk and its by-products) may be playing a dominant role in the prevalence of tuberculosis in the study area. Where distances get further away from the route, climatic factors become more important. This observation reinforces both the role of seasonality among control stations and that of proximity to route of migration among the sample stations in the prevalence of tuberculosis. The tables also show that population size of settlements where the DOTS centres are located may play a role in the prevalence, which further reinforces one of the principles of the gravity model that increase in population size tantamounts to increase in interaction, which may invariably lead to higher prevalence.

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5.2 Spatial variations

5.2.1 Sample DOTS centres

Table 5.1 again shows variations of tuberculosis prevalence among the sample stations. The Specialist Hospital Sokoto has the highest records of tuberculosis prevalence, followed by Yauri, Zuru and Illela. All others have prevalence of less than 100. This shows that the population size of settlements (Table 5.1) where the DOTS centres are located may be the determinant of the prevalence of tuberculosis in those areas.

Figure 5.5 shows the spatial variation for all the sample stations. The Specialist Hospital in Sokoto has the highest prevalence record, followed by General Hospitals at Yauri and Zuru, while the lowest prevalence records are found in Primary Health Centre at Auna and General Hospitals at Dogon Daji and Yabo. This variation could be attributed first to their population sizes (Table 5.1), and second to their being more urbanized. The figure shows a downward trend from Illela at the border with Niger Republic to New Bussa, the southernmost location among the settlements. This trend could be attributed to either the decreasing availability of unpasteurized milk and its by-products as one moves southwards, or the decrease in the consumption of these by-products also as one moves southwards, which has to do with the culture of the people. It could be recalled that this region is dominated by the Hausa/Fulani ethnic group, one of whose staple food items is *fura da nono*, a gruel food prepared from millet and unpasteurized milk. The population of this ethnic group decreases as one moves southwards.

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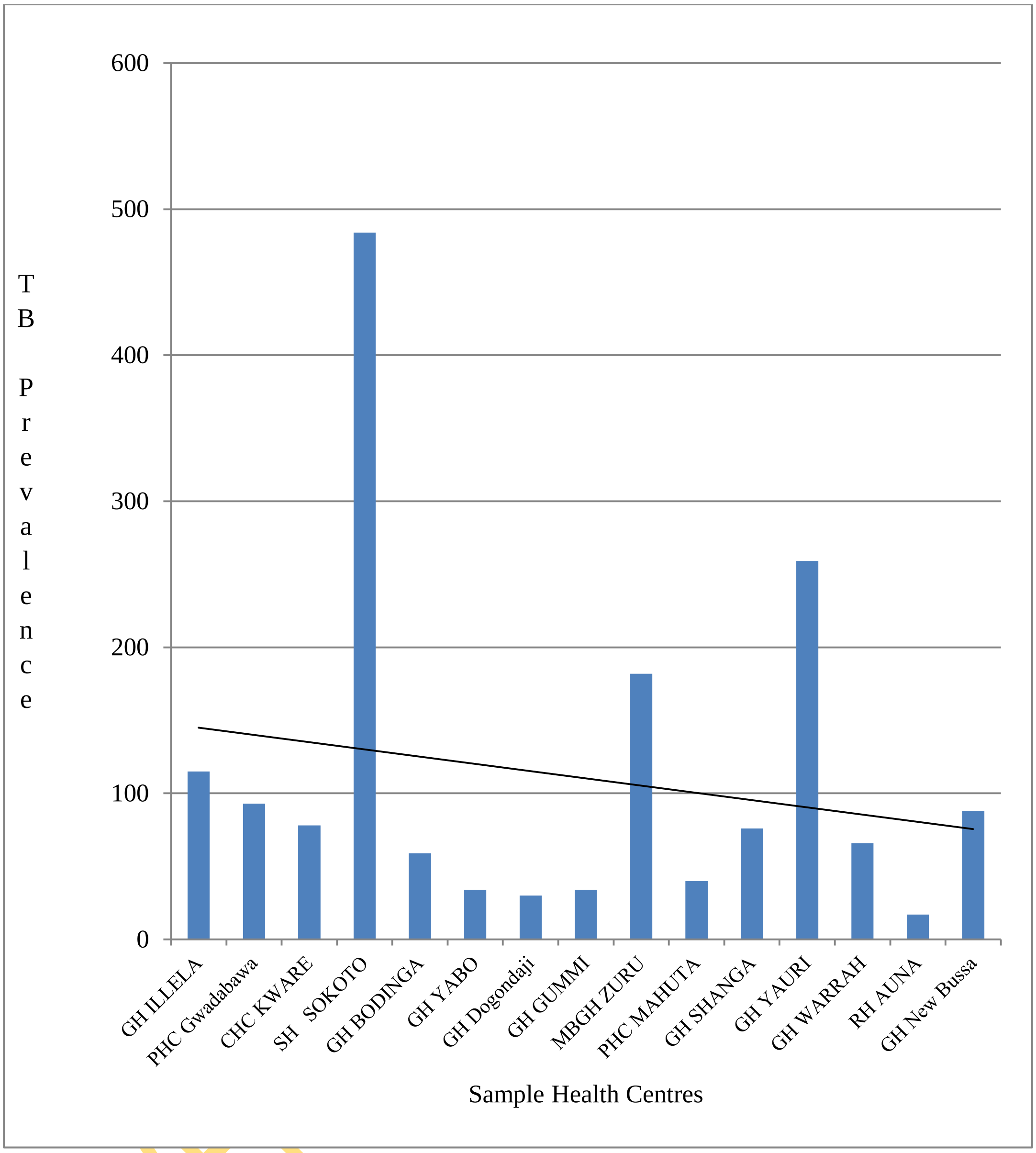

Figure 5.5: Spatial Variation of Tuberculosis Prevalence at all the Sample DOTS Centres in 2010

Source: Fieldwork, January 2011

Figure 5.6 vividly shows the spatial variation for all sample stations. Except for the month of August, there is a general slight downward trend among stations as one moves from the north (places of origin) towards the south (stop-over and destination areas). That is to say, prevalence decreases as you move from the north towards the south or prevalence is higher in the far north than in the south. Whether this could be attributed to the presence of a higher population of cattle in the area or the number of people that take the by-products remains a question to be answered. One could also suspect variations in control programmes among the States in the region as well as socio-economic factors such as literacy and income levels. It can also be seen that some places in the far north (i.e. Kware and Sokoto) and stop-over points (Gummi, Zuru, Shanga and Yauri) have the highest prevalences compared to destination places. The reason for this could be the higher consumprion of unpastuerized milk in *fura da nono* in almost every household in the far north, an ascertion that could be substanciated in the subsequent chapters.

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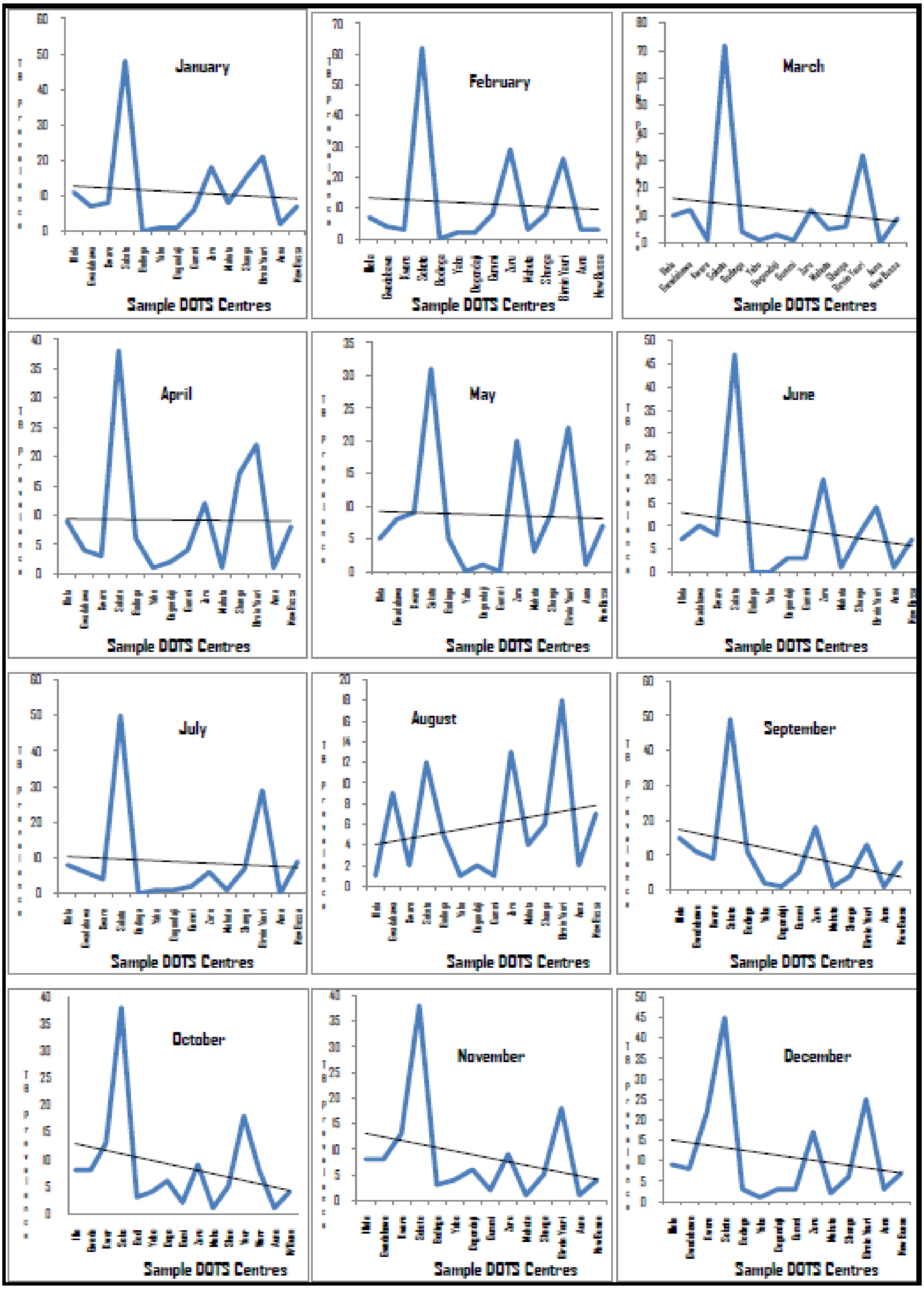

Figure 5.6: Spatial Variation of TB Prevalence at Individual Sample DOTS Centres in 2010

Source: Fieldwork, January, 2011

In the month of August, the trendline showed a slight rise in the prevalence among stations, with higher records still recorded in the places of origin and stop-over. Interestingly, the rise is even more in stop-over places than in the places of origin. The question is, why in the month of August when the migrant Fulani are supposed to be in the far north and not in these places? Could latency of the disease be responsible for its late manifestation and detection or could some other factor be responsible? In the same vain, one finds consistently in Yabo, Dogondaji and Auna very low prevalences. What could the reasons be? Perhaps, August is the month when pastures become most available for increased livestock carrying capacity and the eventual production of unpasteurized milk. It could also be that higher amount of rainfall affects the aetiology of the disease. This study does not however concern itself with the influence of climate, livestock carrying capacity or even production of unpasteurized milk on the transmission and infection of tuberculosis. The indirect effects of these on the availability and subsequent consumption of unpasteurized milk may however be ascertained in the subsequent chapters.

Other reasons that could be considered might include low turnout of patients to such DOTS centres for so many reasons – availability of resources to access the facilities, awareness of availability of service, available diagnostic facilities, attitude of personnel, proximity to other more urbanized DOTS centres with better facilities such as Sokoto, Yauri and Warra, etc. In chapters to come, we may have answers to these. A linear trend line fixed shows an upward trend in the month of August while all other months show a downwaerd trend right from Ilela to New bussa. To summarize, it is obvious that except in August, prevalence generally declines from Illela to New-Bussa, though very gently. Also, neither distance separating the stations nor the period of the year adequately explains the trend of tuberculosis prevalence in the region.

5.3.2 Control DOTS centres

Figure 5.7 shows the spatial variations of tuberculosis prevalence at control DOTS centres. The highest prevalence records are found in Argungu, Aliero and Wurno DOTS centres. The General Hospital Tureta has the lowest prevalence record, followed by Tangaza and Gande. This disparity could be explained first by their

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population size (Table 5.2) which could in any case serve as a confounder. Secondly, stations with the lowest prevalence records are the farthest away from the Fulani migration route, which may implicate the availability of unpasteurized milk and its by-products.

Figures 5.8a to 5.8l show the pattern for all stations for different months. This is similar to the pattern in Figure 5.7, indicating a downward trend, as shown by the trend lines. For each of the months, there are variations among stations. Argungu has the highest prevalence among all stations in January, March, April, May, August and October, while Tureta has the lowest record in January, February, March, April, June and December. Kamba has the highest prevalence in February while Wurno has the highest in July. In May, Wurno ties with Argunugu in terms of high prevalence. In June and December, the highest record is found in Aliero while Gwandu has its highest record in November. Tureta has the lowest record in January, February, March, April, June and December while Goronyo has the lowest in May and August. Gande has the lowest in July and October, while Tanagaza and Tureta have the least in June and December. The explanation could still be related to their population sizes (Table 5.2) and their proximity to Fulani route of seasonal migration.

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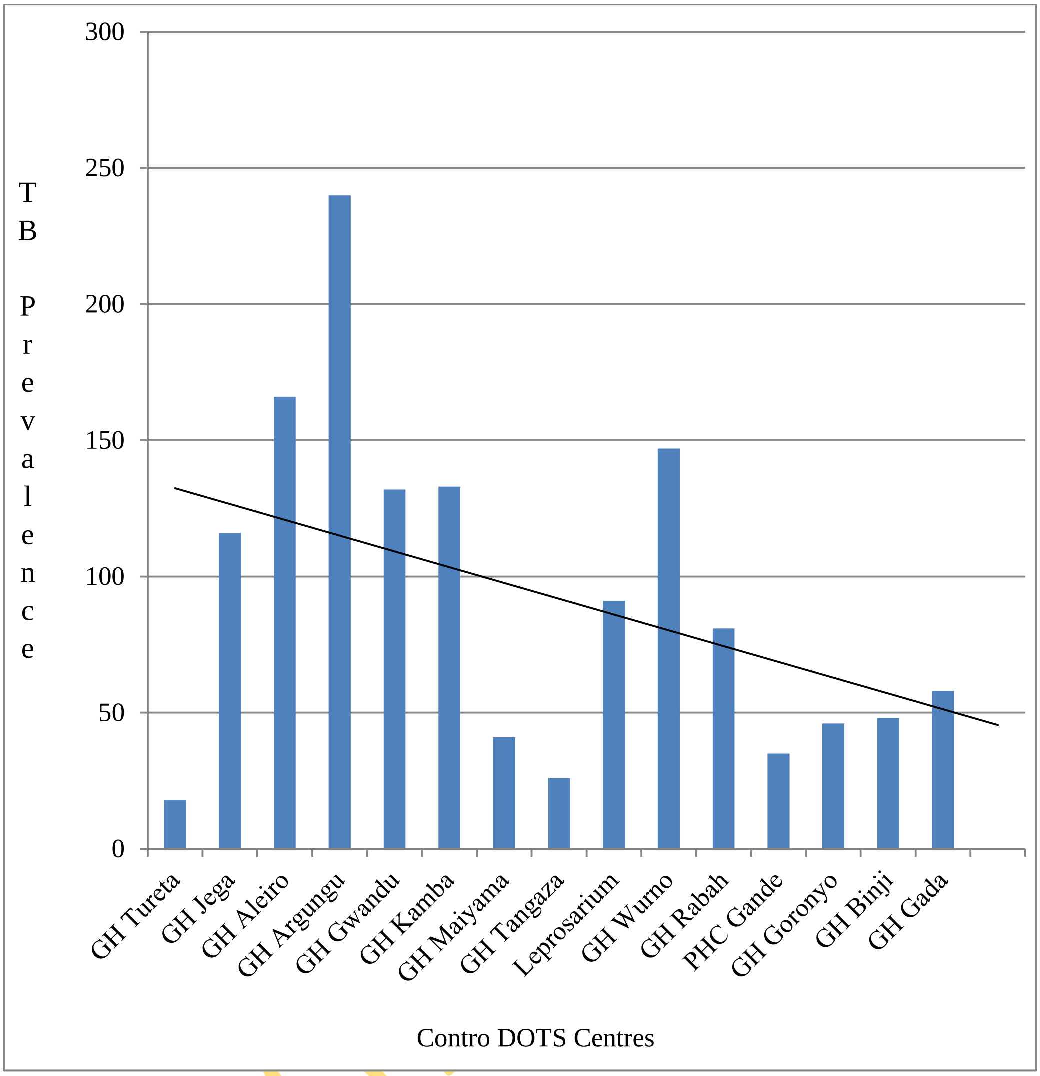

Figure 5.7: Spatial Variation of TB Prevalernce at all Control DOTS Centres in 2010

Source: Fieldwork, January 2011

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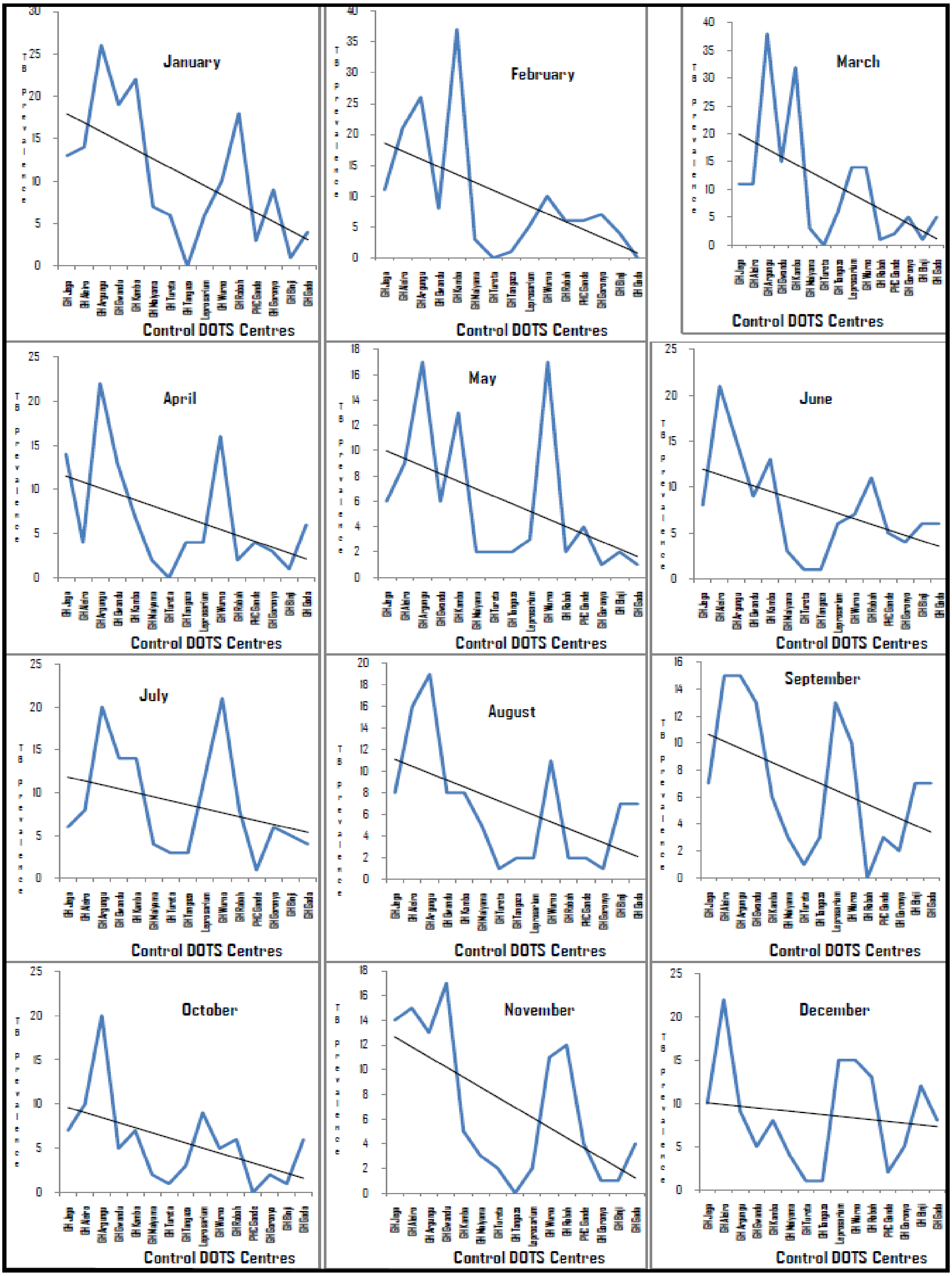

Figure 5.8: Spatial Variation of TB Prevalence at Individual Control DOT Centres in 2010

Source: Fieldwork, January 2011

5.2.3 Sample versus Control DOTS centres

Examining the visual relationships of the sample and control stations (Tables 5.1 and 5.5 respectively) was provided by a prevalence map (Figure 5.9). The data were ranked since all settlements and their prevalence records cannot be shown. In all cases, the sizes of settlements determine the prevalence records, but the highest density of tuberculosis prevalence among all settlements is found closer to the DOTS centres and the Fulani route of seasonal migration. There is always dominance at the DOTS centres in comparism with the settlements where patients come from. In fact, most settlements have records of less than ten patients. This could be atributd to so many factors such as distance, cost of travel, awareness level, etc.

5.2.4. Conclusion

From the foregone, it can be concluded that distances away from the route of migration plays a role in the prevalence of tuberculosis in the study area in so far as variations among control stations are statistically significant.

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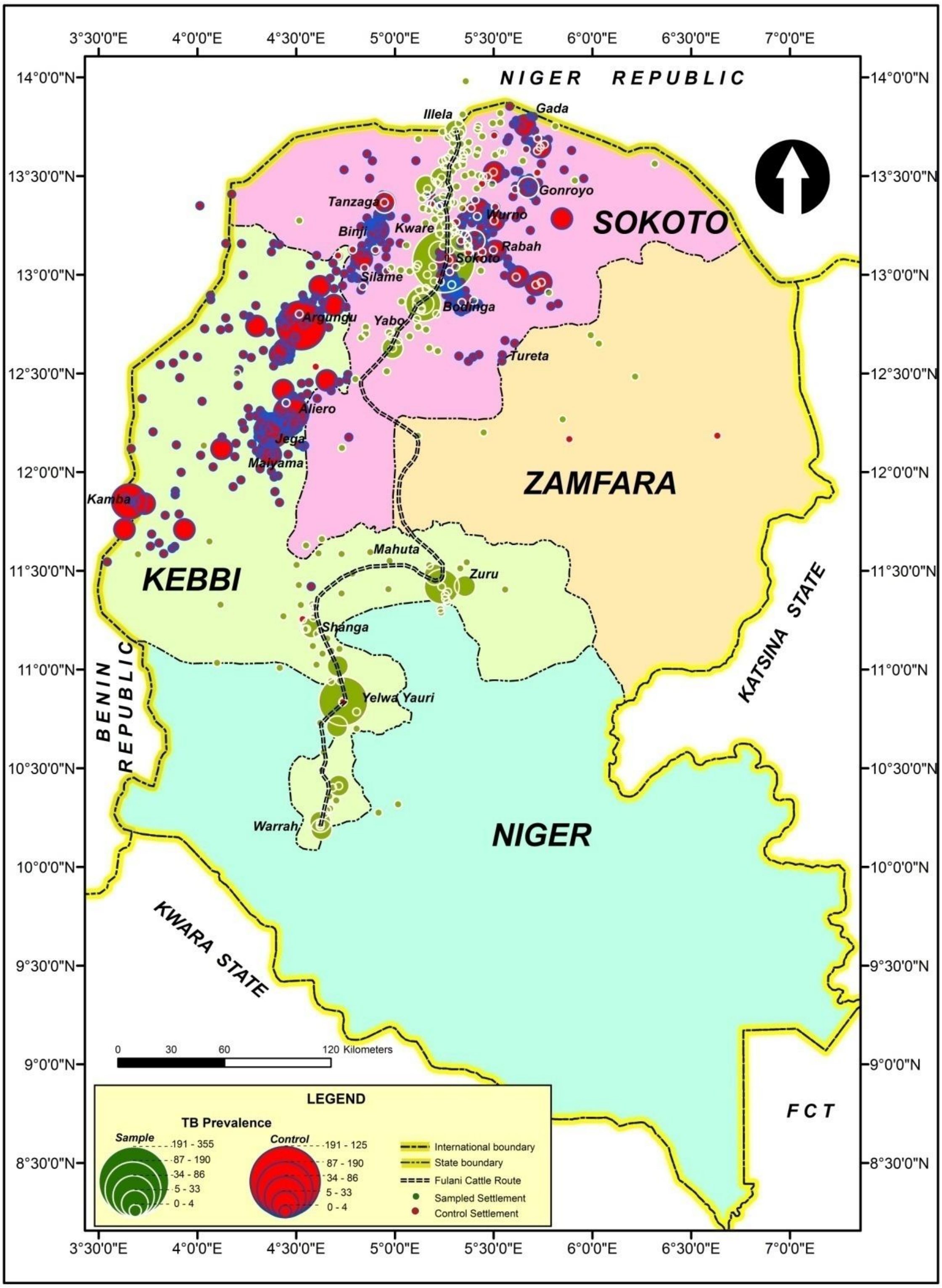

Figure 5.9: Spatial Pattern of TB Prevalence along and away from Fulani Route of Seasonal Migration in 2010

Source: Fieldwork, January 2011

CHAPTER SIX

FACTORS AFFECTING THE PREVALENCE OF TUBERCULOSIS

Introduction

In the last chapter, questions were raised on whether higher prevalence of tubercuolosis could be attributed solely to consumption of unpasteurized milk and its by-products in stop over places or whether we could attribute the general decline in prevalence from the north to the south to cattle population or some other factors. Generally, consumption of unpasteurized milk and its by-products could be determined by the availability (which is subject to the duration of stay of the Fulani and the season) and the culture of the people that take them as staple. This chapter is intended to provide answer to some of these questions.

This Chapter therefore examines the relationship between tuberculosis prevalence and the duration of stay of Fulani in a place as he moves along the route; population size of settlements where patients come from; distances along and away from the migration route; gender and age; as well as the number of functional health facilities available in settlements where data were collected. In all cases, a two-tailed Pearson Correlation Analysis was carried out to determine the degree of association; the t-test was used to test the hypotheses which state that 'distance plays a significant role in determining the prevalence of tuberculosis in the region', and 'males and children are more prone to tuberculosis infection than either females or adults respectively'.

6.1 Distance as a factor in tuberculosis prevalence

6.1.1 Distance of Sample DOTS centres along routes of migration

The role of distance has earlier been stressed, and one would want to see if it plays a role in the present situation. Table 6.1 shows distances along the migration route from Illela (near the border with the Republic of Niger) in Sokoto State up to New Bussa in Niger State. The prevalence of tuberculosis recorded in the various DOTS centres is also indicated. The table indicates that increase in distance along the route southwards is associated with decrease in the prevalence of tuberculosis in the region which is in consonance with the gravity model. In fact, Illela which is the starting

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point recorded higher prevalence than Auna which is almost 427 kilometres away. This agrees with the principles of the *gravity model*, that as distance increases, prevalence decreases. Even though distance appears to play a role in tuberculosis transmission, its significance could have been shadowed by some other factors or confounders. One of these could be the variation in the population sizes of the settlements that may have served as a confounder in concealing the role of distance or in portraying higher prevalence.

A two-tailed Pearson Correlation Analysis was carried out (Using data in Table 6.1, columns 2 and 3) on the working hypothesis which states that 'distance from the origin plays a significant role in determining the prevalence of tuberculosis in the Region'. This is to determine the relationship between distance and tuberculosis prevalence, and to test for its significance. The correlation coefficient (r) of -0.172 (Table 6.2) obtained indicates a weak negative or an inverse correlation between distance and TB prevalence. This is in line with the earlier finding that there is a slight decrease in the prevalence of tuberculosis with an increase in distance within the region. However, since the significance level of 0.541 is greater than the alpha value of 0.05, we reject the hypotheses that 'distance from the origin of migration and away from the route plays a significant role in determining the prevalence in the region'.

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Table 6.1: Distance of Sample DOTS Centres along Route of Migration

DOTS Centre	Distance (Km)	TB Prevalence	Projected 2010 Population	TB Prevalence/ '000 Population
Illela	0.05	115	29345	4
Gwadabawa	46.97	93	22658	4
Kware	60.29	78	16336	5
Sokoto	77.77	484	624569	1
Bodinga	104.48	59	16085	4
Yabo	127.41	34	19319	2
Dogondaji	160.67	30	16084	2
Gummi	200.11	34	57082	1
Zuru	265.17	182	25629	7
Mahuta	279.58	40	11440	4
Shanga	304.93	76	3616	19
Yauri	352.37	259	353457	1
Warrah	415.56	66	13516	5
Auna	426.89	17	11591	1
New Bussa	481.80	88	40361	2

Source: Fieldwork, 2011

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Table 6.2: Correlations between TB Prevalence and Distance along the Migration Route

		Prevalence	Distance
Prevalence	Pearson Correlation	1	-0.172
	Sig. (2-tailed)		0.541
	N	15	15
Distance	Pearson Correlation	-0.172	1
	Sig. (2-tailed)	0.541	
	N	15	15

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The weak negative correlation is however an indication that prevalence decreases with distance. Generally speaking, disease transmission processes do not always follow the rule of distance since hierarchical effects can sometimes occur when diseases spread first to major cities, then to intermediate-size places, and later to small towns for the simple reason that larger places have a greater potential for interaction. With more carriers of a disease coming to a place, large cities have more interactions with other people and places. This was further substantiated by another bi-variate correlation between TB prevalence per 1000 population (Table 6.1, Columns 2 and 5) and distance from the origin of migration, which gave a much weaker, though positive, correlation (r = 0.072) and a significance value of 0.800, which is again greater than the alpha values of 0.05 (Table 6.3). This is at variance with the earlier observation that the greater the distance along the route of migration, the less the prevalence of tuberculosis. It signifies the role of population size acting as a confounder interfering with the distance decay process.

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Table 6.3: Results of Correlation Analysis between Distance from the Origin of Migration and TB Prevalence/ '000 Population.

		Distance from the Origin	TB Prevalence/ '000 population
Distance from the Origin	Pearson Correlation	1	0.072
	Sig. (2-tailed)		0.800
	N	15	15
TB Prevalence/ '000 population	Pearson Correlation	0.072	1
	Sig. (2-tailed)	0.800	
	N	15	15

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The role of physical distance in disease transmission has earlier been stressed in the literature review. The basic assumption is that the probability of contacts and interactions between people in two places depends on the distance separating them as well as the population characteristics of the two locations. The weak negative relationship of prevalence with distance connotes the role of distance in the prevalence of tuberculosis. We may want to concur with Chigbu *et al* (2010:2-3) and Erahl *et al* (2009:11) who argued that tuberculosis transmission could be due to a number of factors or their combinations; the physical environment, characteristics of the disease agent, intensity of exposure and the susceptibility and immune status of the exposed individual, as well as the socio-economic status of the people among others. We may also want to agree with Dye *et al* (2009:689), who believe that tuberculosis incidence trends may result from numerous biological, social and economic variables, and therefore "strong correlation does not necessarily reflect a causal link and the absence of a correlation does not exclude causality".

6.1.2 Distance of settlements to Sample DOTS centres

It was reiterated that geographical references for all stations could not be obtained, and thus distances were computed for only those with this information. Therefore, Auna, Gummi and New Bussa were excluded from the analysis for the simple reason that distances from the patients' home settlements to these DOTS centres could not be determined. In most cases, distance to health facility plays a role in the number of patients turn out. To determine the relationship between tuberculosis prevalence and distances to the sample health (DOTS) centres, a two-tailed Pearson Correlation Analysis was first carried on the individual DOTS centres using data in Appendix III.

Table 6.4 gives the correlation coefficients (*r* values) and the significance levels for each of the centres in respect of distances where patients come from. Except for Gwadabawa and Dogondaji centres, all others show no significant relationship between distance to the DOTS centres and prevalence because the significance levels were greater than the alpha values of 0.05. Dogondaji has a very strong negative relationship (r = -0.659) which is significant (0.027) at 0.05 alpha significance level. This is an indication that the longer the distance the lower the prevalence. Similarly, even though Gwadabawa shows a weak negative relationship (r = -0.351), this relationship is significant (0.045) at 05 significance level.

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Table 6.4: Correlation Coefficients of TB Prevalence and Distance of Patients' Origins to DOTS Centres

DOTS Centre	No. of places where patients come from	Correlation coefficient (*r*)	Significance level (2-tailed)
Illela	39	-0.289	0.70
Gwadabawa	33	-0.351	0.045
Kware	22	-0.284	0.200
Sokoto	53	-0.169	0.226
Bodinga	6	-0.401	0.431
Yabo	6	-0.366	0.476
Dogondaji	11	-0.659	0.027
Zuru	14	-0.492	0.074
Mahuta	11	-0.411	0.209
Shanga	22	-0.030	0.896
Yauri	14	-0.118	0.688
Warrah	15	-0.349	0.203

Source: Fieldwork, January 2011

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For these two centres therefore, as distance increases, prevalence decreases. This again concurs with the views of Chigbu *et al* (2010), Erahl *et al* (2009) and Dye *et al* (2009) and also agrees with the general principles of the *distance decay theory*. The fact that TB prevalence decreases with distance is a testimony of the role of mobility in the prevalence of TB in the region. The Fulani and their livestock could be acting as carriers, transmitting the disease to susceptible individuals both along the way and at the destinations and because this movement is seasonal (and interaction becomes less as you move southwards), the temporal variation showed a north-south downward trend. The role of human mobility has been observed by Babatola (2006), Hardie *et al* (2007) and Cetron *et al* (1998: 2), who argued that travellers may not only be responsible for the spread of infectious agents along the way, but are also ideal sentinels for the arrival of an infectious agent in a new community.

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The reason for the strong negative relationship in Dogondaji DOTS centre could be explained by the fact that the town is located in close proximity to Tambuwal and Gwandu towns (off the route of migration) which also have DOTS centres and are less than twenty kilometres away from Dogondaji. There is every tendency that patients could report to these centres in preference to Dogondaji due to proximity and being more urbanized. Thus, as one moves away from Dogondaji, other facilities become immediately available and the number of cases reporting to Dogondaji DOTS centre also decreases drastically. Therefore, the decrease in prevalence could simply be due to availability of facilities and not due to increased distance away from Dogondaji DOTS centre.

6.1.3 Distance of settlements to Control DOTS centres

Control DOTS centres are all DOTS centres located off the identified Fulani route of seasonal migration. The essence of selecting these centres is to examine whether proximity to the route of migration plays any role in the prevalence of tuberculosis. To show whether the Control DOTS centres portend similar characteristics with the sample DOTS centres in relation to distance to health facilities, distances to individual DOTS centres were computed and a two-tailed Pearson Correlation Analysis was carried out to test the significance of the relationship between tuberculosis prevalence and distance to those centres. Appendix IV shows the distances computed for the various settlements where patients come from and their respective DOTS centres. Table 6.5 shows the results of the correlation analysis for each of the centres, using data from different settlements where patients come from. General Hospital (GH) Gwandu, GH Tureta and Primary Health Centre (PHC) Gande show high negative correlations, thus as the distance increases to the DOTS centres, prevalence of tuberculosis decreases drastically showing an inverse relationship between the two. However, only PHC Gande has a statistically significant relationship (0.021) at 0.05 alpha level. In other words distance plays a role in determining TB prevalence only in this centre. For the rest of the centres, both positive and negative correlations are weak, and not significant.

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Table 6.5: Correlation Coefficients of TB Prevalence and Distance of Patients' Origins to Control DOTS Centres

DOTS Centre	No. of places where patients come from	Correlation coefficient (*r*)	Significance level (2-tailed)
GH Gwandu	11	-0.564	0.071
GH Aliero	31	-0.295	0.101
GH Argungu	61	-0.172	0.184
GH Jega	35	-0.192	0.289
Amanawa Leprosarium	42	0.039	0.807
GH Binji	27	0.208	0.299
GH Kamba	24	-0.315	0.134
GH Tureta	9	-0.612	0.107
GH Maiyama	19	-0.249	0.305
GH Tangaza	15	-0.064	0.821
PHC Gande	19	-0.526	0.021
GH Wurno	38	-0.159	0.341
GH Rabah	24	-0.255	0.228
GH Gada	24	-0.316	0.132
GH Goronyo	20	-0.091	0.703

Source: Fieldwork, January 2011

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6.1.4 Distance of Control DOTS centres to route of seasonal migration

Distances of control DOTS centres to the Fulani route of seasonal migration were computed (Table 6.6 and Appendix V) to determine whether distance away from this route plays any role in the prevalence of tuberculosis in those places. The relationship was determined using a two-tailed Pearson Correlation Analysis and the results (Table 6.7) indicate a very weak positive relationship (r = 0.111) with no statistical significance (p = 0.693) at even 0.05 alpha level. In other words, there is no relationship between proximity to the route and the prevalence of tuberculosis in the areas. Put another way, distance to the route does not determine the prevalence of tuberculosis. This refutes our hypothesis which states that "distance away from the route plays a significant role in determining the prevalence of tuberculosis in the region". This is because not only is the coefficient positive, it is also not statistically significant.

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Table 6.6: Distance of Control DOTS Centres to Route of Migration

DOTS Centre	Recorded TB Prevalence	Distance to Route of Migration (Km)
GH Kamba	133	148
GH Argungu	240	54.7
GH Aliero	166	53.7
GH Jega	116	76.6
GH Gwandu	132	20
GH Maiyama	41	77.8
PHC Gande	35	43.8
GH Tangaza	26	31.2
GH Binji	48	37.3
GH Goronyo	46	44.5
GH Gada	58	37.8
GH Tureta	18	65.3
Amanawa Lepro.	91	12.2
GH Rabah	81	28.4
GH Wurno	147	19.5

Source: Fieldwork, January 2011

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Table 6.7: Results of Correlation Analysis between Distance of Control DOTS Centres to Route of Migration and TB Prevalence

		Prevalence	Distance to route
Prevalence	Pearson Correlation	1	0.111
	Sig. (2-tailed)		0.693
	N	15	15
Distance to route	Pearson Correlation	0.111	1
	Sig. (2-tailed)	0.693	
	N	15	15

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6.2 Population size of settlements and tuberculosis prevalence

The prevalence of tuberculosis could be a function of population size of settlements in the study area. The projected population size of settlements for the year 2010 was determined using the exponential population growth rate:

$$A_f = A_b * (1 + \%/100)^{(f-b)}$$

where *A* is the population, *f* is the future year, *b* is the base year and % is the growth rate per year. With a growth rate of 3.4%, the population figures of the settlements were computed for the year 2010 using the 1991 figures as the base. These are provided in Table 6.8 and Appendix II

Generally speaking, higher prevalence is reported in settlements with larger population sizes. In other words, the larger the population size of a settlement, the higher the rate of tuberculosis prevalence reported. This applies to all the sample DOTS centres and places where patients came from. Similarly, if one considers settlements where the DOTS centres are located (Table 6.8), their population size correlates positively with the prevalence of tuberculosis. This finding shows that the size of a settlement is implicated in the prevalence based on the premise that the higher the population size of a settlement, the higher would be the level of interaction and the consequent rate of transmission. However, there are variations among settlements with comparable population sizes. Auna for instance, with a population of 40361 has much lower tuberculosis prevalence than Zuru with a population of 11440, in line with the principle of hierarchy. Therefore, even though population size may be a determinant of tuberculosis prevalence, some other factors may be at play at some stations.

In another vein, the higher prevalence among settlements where DOTS centres are located is an indication of better access to and utilization of the DOTS service or the characteristics of the population in these settlements (which are more urbanized and literate). Not only does this population earn better income because of the literacy level, it is also more aware of the services, in contrast to the more rural population. Added to this is the possibility of more prevalence due to greater contacts consequent upon greater population size.

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Table 6.8: Sample DOTS Centres, TB Prevalence and Projected Population Size

Settlement	TB Prevalence	Projected 2010 Population
Gwadabawa	115	22658
Illela	93	29345
Sokoto	484	624569
Kware	78	16336
Bodinga	59	16085
Yabo	34	19319
Dogondaji	30	16084
Gummi	34	57082
Zuru	182	11440
Mahuta	40	3616
Shanga	76	25629
Yauri	259	35457
Warra	66	13516
Auna	17	40361
New Bussa	88	11591

Source: NPC (1991) and Fieldwork, 2011

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Determination of the correlation between prevalence and population size was first preceded by a scatter-plot with a trend line (Figure 6.1). The essence is to visualize the pattern of the relationship in a graphical form before uncovering the significance. The trend line shows the relationship between prevalence and population size and is represented as Y = 0.0005x + 0.2446 where Y is the prevalence, 0.2446 is the Y intercept while 0.0005X is the effect of population size on prevalence. The coefficient of determination (R^2; 0.5846) represented the extent of variability in the prevalence explained by population size. A two-tailed Pearson Correlation Analysis was then carried out to determine the degree of relationship between population size of settlements and tuberculosis prevalence and results (Table 6.9) indicate a high positive relationship (r = 0.765) at 0.05 significance level with the *p*-value of 0.000 which is less than the alpha level of 0.05. There is therefore a significant relationship between population size and prevalence. The finding supports our working hypothesis which states that “the higher the population size of settlements, the higher the recorded tuberculosis prevalence in the study area”. Our hypothesis is therefore accepted since *p*-value 0.000 is less than the alpha value 0.05.

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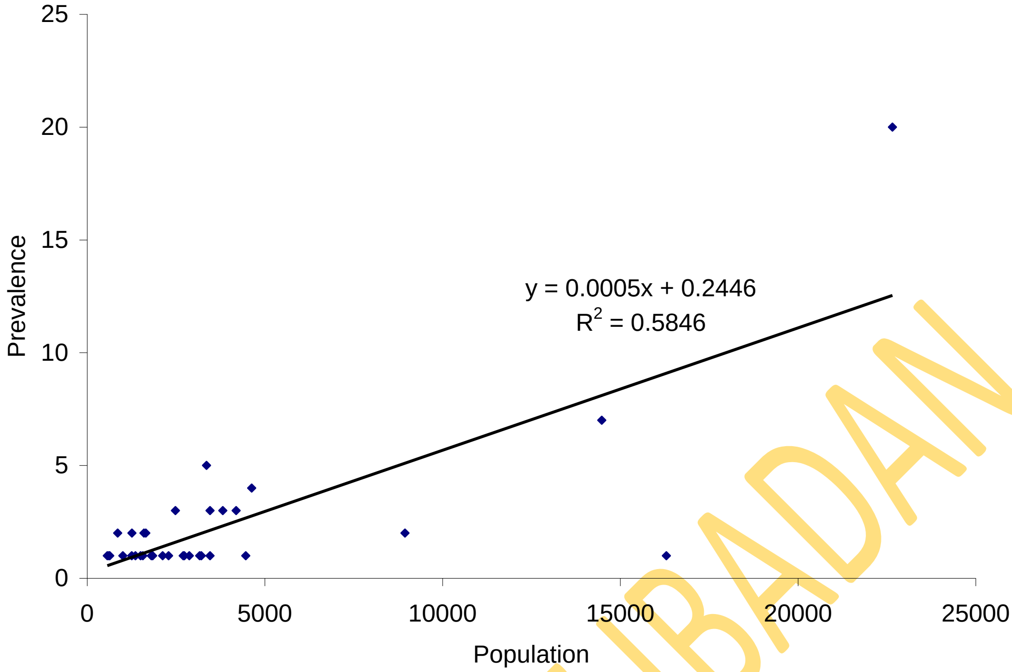

Figure 6.1: Scatter Plot of TB Prevalence in Relation to Population Size of Settlements
Source: Fieldwork, January 2011

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Table 6.9: Results of Correlation Analysis between Population Size of Settlements and TB Prevalence

		Prevalence	Population
Prevalence	Pearson Correlation	1	0.765**
	Sig. (2-tailed)		0.000
	N	33	33
Population	Pearson Correlation	0.765**	1
	Sig. (2-tailed)	0.000	
	N	33	33

**. Correlation is significant at the 0.01 level (2-tailed).

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As earlier reiterated in the literature review, population size affects the level of interaction, which invariably also affects the level of infection of a disease. Nonetheless, one has to be cautious in concluding because population size may sometimes simply act as a confounder. It is possible that there could be falsely low prevalence in some areas due to problems of access to health care by those with tuberculosis. It has been stressed that evidence of disease clusters is difficult to prove because of confounding factors such as uneven population distributions among places, age, gender and ethnicity which may shadow the effects of the actual risk factors at play (Albert *et al*, 2000). Wallace *et al* (1997) have also noted the role of the characteristics of the disease agent (e.g. virulence, incubation period, mode of transmission, etc.) and the population which it affects in addition to some other risk factors. Even though we cannot ascertain precisely who contracted the disease first among the settlements, the fact is population size is an indicator of possible contacts that may translate to higher prevalence.

6.3 Number of health facilities and TB prevalence

Here, we may want to know whether the number of health facilities in places where cases were registered had any influence on the recorded prevalence. Table 6.10 shows the number of functional health facilities in places where DOTS centres are located and the recorded tuberculosis prevalence. From the table, there is some degree of relationship between tuberculosis prevalence and number of health facilities. Sokoto DOTS centre which has the highest recorded prevalence of tuberculosis also shows a larger number of available functional health facilities, while Auna DOTS centre with the lowest prevalence has the smallest number of such health facilities. The trend goes to show that those with more health facilities also provide more opportunities for patients to seek medication for other tuberculosis-related diseases (such as HIV/AIDS) from centres other than the DOTS centres. It also means some of the patients can get treated before tuberculosis becomes manifest for the DOTS centre to attend to. This also means that in the absence of these health facilities, latent forms of tuberculosis could have given rise to more prevalence of tuberculosis, all other factors being equal.

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Table 6.10: Number of Health Facilities in Relation to TB Prevalence in Sample DOTS Centres

DOTS Centre	Number of Health Facilities	Recorded TB Prevalence
Illela	4	115
Gwadabawa	2	93
Kware	3	78
Sokoto	44	484
Bodinga	2	59
Yabo	2	34
Dogondaji	2	30
Gummi	4	34
Zuru	5	182
Mahuta	1	40
Shanga	1	76
Yauri	5	259
Warra	2	66
Auna	1	17
New Bussa	11	88
Total	**89**	**1655**

Source: Fieldwork, January 2011

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As a prelude to testing for correlation between tuberculosis prevalence and the number of health facilities, linearity was first tested between them as shown in Figure 6.2. Due to the observed linearity between both variables, a two-tailed Pearson Correlation Analysis was carried out to measure the degree of this relationship. The correlation coefficient (0.772) from the linearity test showed that the number of functional healthcare facilities has much impact on prevalence. The two-tailed Pearson Correlation (Table 6.11) also gave a significant positive correlation (0.879) at 0.05 level, which strengthened our confidence that there is a linear relationship between the two variables. The *p*-value (0.000) is also less than the alpha level of 0.05. The finding attests to the possible role of availability of healthcare facilities in determining tuberculosis prevalence. This finding also goes hand in hand with the earlier finding on population size and prevalence. Places with large population tend to have more health facilities. The question therefore is, could the higher population sizes have attracted higher number of health facilities, which attracted more patients? This is certainly so since the larger the population size of our settlements, the more urbanized they are and consequently the more attraction for health facilities to cater for the teaming population.

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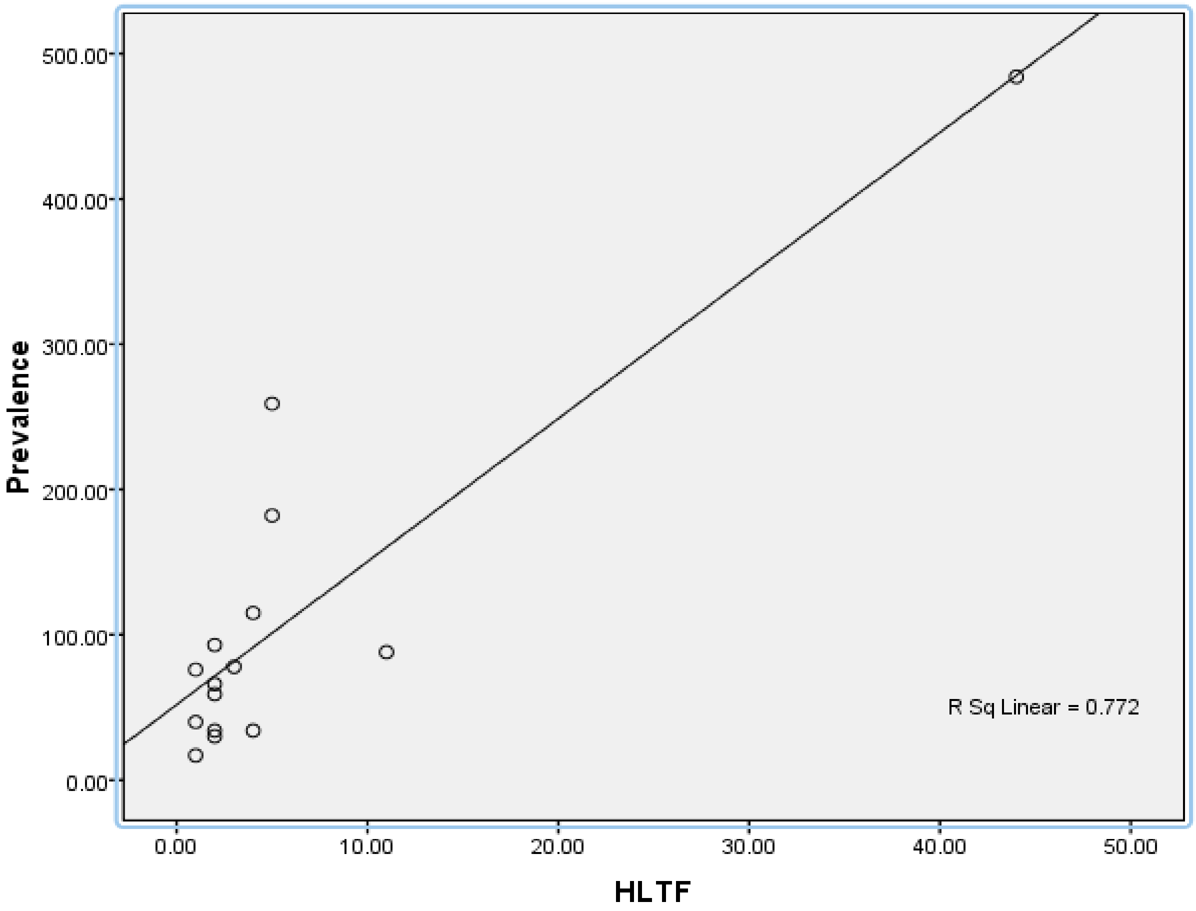

Figure 6.2: Number of Health Facilities in Relation to TB Prevalence in 2010

Source: Fieldwork, January 2011

Table 6.11: Correlation Coefficients of Available Health Facilities and TB Prevalence

		Prevalence	Health Facility (HLTF)
Prevalence	Pearson Correlation	1	0.879**
	Sig. (2-tailed)		0.000
	N	15	15
Health Facility (HLTF)	Pearson Correlation	0.879**	1
	Sig. (2-tailed)	0.000	
	N	15	15

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

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6.4 Age of patients and tuberculosis prevalence

Table 6.12 and Figure 6.3 show variations among the age groups in relation to tuberculosis prevalence. In fact, age groups 21-30, 31-40 and 41-50 are the most affected. These are the most productive groups in society. Patients of ages greater than 61 are the least affected. The importance of age in tuberculosis infection has been reported by a number of authors (Hussain *et al*, 2003, Touray *et al*, 2010 and Carbonara *et al*, 2005). Carbonara *et al* (2005) have for instance observed that inmates of age 30 years have a four-fold greater risk for *Mycobacterium tuberculosis* infection than younger subjects. Our finding therefore agrees with Carbonara *et al* (2005)'s and Touray *et al* (2010)'s findings that tuberculosis mostly affects people aged fifteen to forty-five years. It is also in consonance with the works of Rafiza *et al* (2011) who discovered age groups 25 to 29 and above 35 years to be vulnerable to TB infection; that of Ekrakene and Igeleke (2010) that observed age groups 30-40 (42.84%), 31-35 (33.33%) and 25-30 (20%) as being more prone to infection; that of Lienhardt *et al* (2003) which indicated increased infection with age; and that of Gupta *et al* (2011) that reported age group 21-40 years with the highest risk, followed by 41-60 years. However, our finding disagrees with Kirk's (2003) and Ofukwu's (2006) view that children are affected, as well as Davies's (2006) and HPA's (2009) opinions that the older age are more affected. To attest to Ofukwu's (2008) view that up to 3% of zoonotic tuberculosis cases due to *M. bovis* in Nigeria is in children less than five years of age therefore requires more rigorous clinical tests to distinguish the types of tuberculosis diagnosed. Whatever the case might be, one wonders why the elderly were not so much affected in view of their advanced age (a risk factor) which reduces immunity and promotes infection.

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Table 6.12: Tuberculosis Prevalence in Relation to Age Group

Health Facility	TB Prevalence	AGE GROUP					
		0-20	**21-30**	**31-40**	**41-50**	**51-60**	**>=60**
GH Illela	115	7	36	42	17	8	5
PHC Gwadabawa	93	8	19	31	15	13	7
CHC Kware	78	7	24	26	11	7	3
SH Sokoto	484	88	197	182	96	52	25
GH Bodinga	59	3	19	23	10	3	1
GH Yabo	34	0	9	18	5	1	1
GH Dogondaji	30	2	6	9	6	4	3
GH Gummi	34	4	5	10	7	5	3
MBGH Zuru	182	21	57	43	37	21	3
PHC Mahuta	40	4	7	13	11	5	0
GH Shanga	76	3	15	24	19	13	2
GH Yauri	259	43	75	61	51	16	13
GH Warra	66	10	24	17	9	3	3
RH Auna	17	1	4	3	5	3	1
GH New Bussa	88	12	21	24	12	14	5
Total	**1655**	**213**	**526**	**415**	**311**	**168**	**75**

Source: Fieldwork, January 2011

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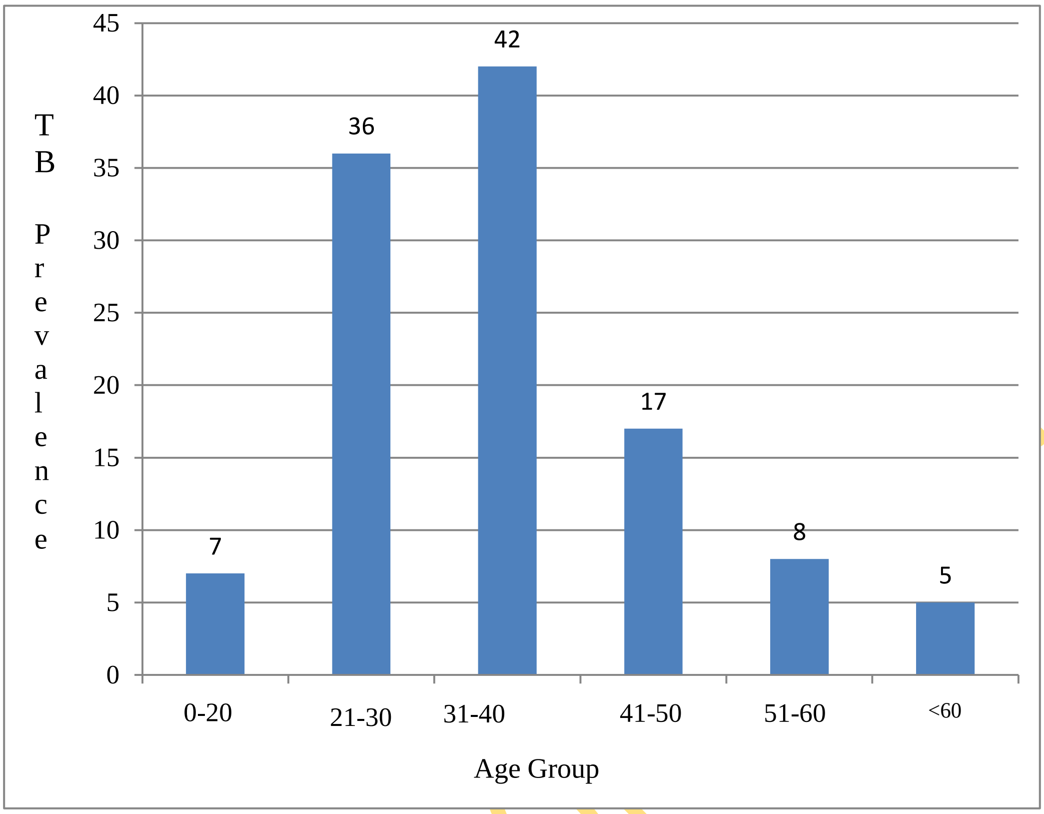

Figure 6.3: Age Group and Tuberculosis Prevalence

Source: Fieldwork, January 2011

Caution needs to be exercised because the ages that people usually report may not be their actual ages because of the tendency to exaggerate or round up their ages. The question therefore is, could it be that the middle-aged (21-50 years) are more exposed to some other socio-economic and environmental risk factors than the children and the aged due to their greater mobility and interaction? It is probable that the middle-aged are more exposed to the disease because of their greater mobility and stress which reduce their immunity. This has been observed by Lienhardt *et al* (2003) who noted that the observed difference in the infection after adolescence could be due to greater exposure among adult males because of their different social role and economic activities, as well as differences in susceptibility to tuberculosis infection. It is also probable that children have higher immunity and lesser mobility than the adults. The risk of HIV/AIDS infection (an opportunistic disease and a risk factor to tuberculosis infection) is also reported to be more common among the adults than the children.

Data for individual stations (Table 6.12) also indicate that ages greater than sixty have the lowest prevalence, except for Zuru and Yabo. The high prevalence in Zuru supports the view that old age could be a risk factor in tuberculosis infection. The departure from the rest of the stations may have to do with the lifestyle of the patients or some other factors.

Testing for significant variations in prevalence amongst the age groups using a One-Way Analysis of Variance indicated no statistically significant difference between the age groups, F (38,51) =0.723, p=0.850 since the p-value is greater than the alpha value of 0.05 significance level (Table 6.13). This implies that the age groups do not differ significantly in the prevalence of tuberculosis. Furthermore, the significantly lower *Between Group Variation* than the *Within Group Variation* implies no statistically significant difference between the groups. Thus, age does not really matter in the prevalence of tuberculosis in the study area. The finding therefore refutes our hypothesis that says ‘children are more prone to tuberculosis than adults’

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Table 6.13: The Results of the Analysis of Variance on Age

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	91.925	38	2.419	0.723	0.850
Within Groups	170.575	51	3.345		
Total	262.500	89			

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6.5 Gender

Data on gender and tuberculosis prevalence are presented in Table 6.14. The table indicates higher prevalence among males than females. This is also true for all stations except Mahuta and Shanga which show slight differences among the different gender. The higher prevalence among males could be attributed to many factors. One of these could be their level of exposure to dust due to the nature of their farm work. It could also be due to their greater mobility and interaction than females who are mostly kept in their houses as a result of pudah. Above all, the high prevalence of tuberculosis among male is usually attributed to a combination of behavioural, socioeconomic, and biological/genetic factors (Mohammed *et al*, 2011; Yim *et al*, 2010; Lienhardt *et al*, 2005 and Singh *et al*, 2007). Another reason could be the health-seeking behaviour of the gender, particularly with the varying cultures and traditions across the region. More often than not, women have less power relations than men in decision-making in the households, even when it affects their health because of certain societal values.

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Table 6.14: Tuberculosis Prevalence in Relation to Gender

Health Facility	Gender	
	Male	Female
GH Illela	58	23
PHC Gwadabawa	68	23
CHC Kware	59	25
SH Sokoto	415	163
GH Bodinga	31	10
GH Yabo	8	7
GH Dogondaji	22	8
GH Gummi	26	11
MBGH Zuru	120	74
PHC Mahuta	14	19
GH Shanga	46	51
GH Yauri	151	107
GH Warra	37	34
RH Auna	10	7
GH New Bussa	51	35
Total	**1116**	**597**

Source: Fieldwork, January 2011

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Testing the hypothesis which states that 'males are more prone to tuberculosis infection than females', was carried ou using the t-test and the results presented in (Table 6.15) indicated a significant difference in the means of gender variables (males and females), t=2.134; p=0.05, under 14 degrees of freedom at 0.05 significance level since the probability is less than the alpha value of 0.05. In other words, gender is important in the prevalence of tuberculosis in the study area.

The finding therefore supports our hypothesis which says 'males are more prone to tuberculosis infection than females'. It also agrees with the general belief that males are more prone to tuberculosis infection than females due to their greater exposure as shown in Table 6.14. In particular, it agrees with the work of Itah and Udofia (2005) that found males to be more prone to tuberculosis infection than females, a situation which they attributed to men's greater interaction with different persons. It also agrees with the work of Liao *et al* (2012) that found higher prevalence of tuberculosis among males than females, and part of Lienhardt *et al's* (2003) which found rate of tuberculosis infection to be higher in males than females with increase in age. It however disagrees with a portion of the same work (Lienhardt *et al*, 2003) that found similar tuberculosis infection rates among males and females at ages 15-20. Thus, to substantiate the finding that males are more prone to tuberculosis infection than females, further studies need to be carried out, particularly with regard to the presence of confounder variables such as age and uneven population distribution which may shadow the effect of other risk factors (Dye *et al*, 2009; Erahl *et al*, 2009; Lam *et al*, 2004; Arcavia, 2004 and Chigbu *et al*, 2010).

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Table 6.15: Test of Mean Difference (t-test) for Gender

Paired Differences							
			95% Confidence Interval of the Difference				
Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
3.46000E1	62.78740	16.21164	-.17050	69.37050	2.134	14	0.051

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6.6 Duration of stay of nomadic Fulani in a settlement

Information on the duration of stay of Fulani is presented in Table 6. 16. The table shows the prevalence of tuberculosis in different settlements where migrant Fulani stop-over in both dry and rainy seasons. Except for Kainji, all places show a decreasing trend of tuberculosis prevalence in relation to the number of days spent by the Fulani in those places. In other words, there is negative relationship between the number of days the Fulani spend in a place and the prevalence of tuberculosis in that area. In fact, places with longer duration of stay recorded the lowest prevalence. This goes to fault the assertion that the number of days a Fulani stops over in a place (which might determine availability of unpasteurized milk and its consumption in that area) may be responsible for the prevalence of tuberculosis in this part of the country. In other words, it is either duration of stay does not necessary determine availability of unpasteurized milk, or availability does not necessarily imply consumption and the supposed infection due to consumption. It is possible that most people in the stop-over places do not consume unpasteurized milk or its by-products, looking at their ethnicity and cultural backgrounds: mostly non-Hausas or Fulani. *Fura da nono* (which consists of mostly unpasteurized milk) and *man shanu* (cow butter) appear to be more peculiar to the Hausas and Hausa-Fulani ethnic groups. It is therefore no surprise that unpasteurized milk or its by-products may not play a significant role in affecting the prevalence of tuberculosis in those areas.

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Table 6.16: Duration of Stay of Pastoral Fulani Nomads

Settlement	Duration of Stay (Days) for all seasons	Prevalence from all Stations
Gayari	164	0
Gwalli	143	2
Saula	145	0
Indire	140	0
Sabon Birni	164	0
Gambandar Magiro	6	0
Mahuta	10	14
Marafa	6	1
Atuwo (Tuwo)	6	5
Birnin Yauri	24	3
Makrin (Malando)	28	1
Garin Baka	8	0
Ngaski	6	21
Auna	8	11
Amfani	6	0
Kainji	6	30
Oli	28	0
Wawa	56	5

Source: Fieldwork, January 2011

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A scatter-plot with a trend line, showing the relationship between duration of stay and tuberculosis prevalence given by the equation Y = 0.0527 + 7.9617X, where Y is the prevalence, 0.0527 is the interception of duration of stay with the prevalence while 7.9617X is the contribution of duration of stay in determining the prevalence. The relationship shows that as the duration increases, prevalence reduces. This is shown in Figure 6.4. The results of the Pearson Correlation Analysis (Table 6.16) carried out to examine the hypothesis which states that there is a relationship between the duration of stay of the Fulani in a settlement and the prevalence of tuberculosis also showed a weak negative correlation (-0.396), which suggests that the prevalence has an inverse relationship with the duration of stay. The coeffient of determination (R^2 = 0.157) shows that only about 16% of the variation in prevalence is accounted for by duration of stay (Figure 6.4). The *p*-value (0.104) is also greater than the alpha value of 0.05, which still shows lack of significance in the relationship.

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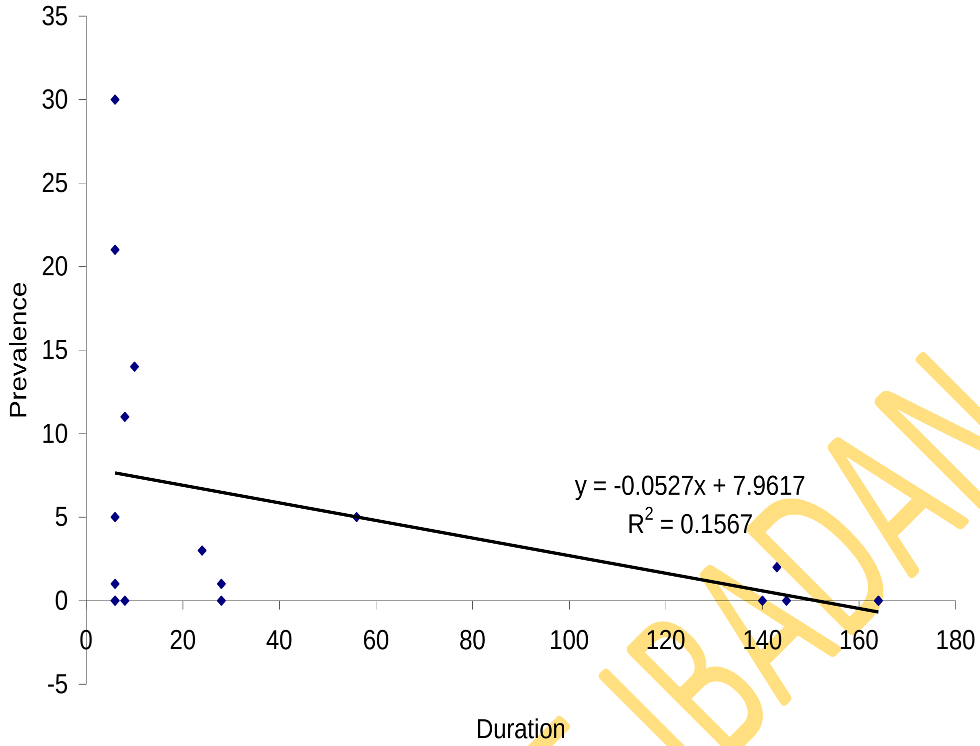

Figure 6.4: TB Prevalence in Relation to Duration of Stay of Nomadic Fulani in 2010

Source: Fieldwork, January 2011

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Table 6.17: The Results of the Correlation Analysis between Duration of Stay and TB Prevalence

		Duration of Stay	Prevalence
Duration of Stay	Pearson Correlation	1	-0.396
	Sig. (2-tailed)		0.104
	N	18	18
Prevalence	Pearson Correlation	-0.396	1
	Sig. (2-tailed)	0.104	
	N	18	18

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If duration of stay of the Fulani does not have much influence on the prevalence of tuberculosis in the stop-over areas, it could be that the availability and consumption of fresh milk or its by-products may not be responsible for the prevalence. Perhaps, some other factor could be responsible for the prevalence in view of the lack of correlation between the variables (tuberculosis prevalence and consumption of unpasteurized milk that will be examined in the next chapter). To substantiate the belief that availability of unpasteurized milk due to longer duration of stay of the Fulani is tantamount to greater infection requires further research pertaining to the cultural background of the people. The culture of a people generally determines their nutrition and the way they keep their environment, which may invariably affect disease transmission.

6.7 Conclusion

This chapter discussed the roles of the duration of stay of Fulani in a place, population size of settlements, distances along the migration route and to DOTS centres, gender, age and the number of functional health facilities available in settlements where data were collected. From the foregone, it is obvious that population size and the number of functional health facilities have direct bearing on the prevalence of tuberculosis in the study area, as they have significant statistical relationships. Age influences the prevalence of tuberculosis in the study area, which refutes the hypothesis that 'children are more prone to tuberculosis infection than adults'. Similarly, the influence of the duration of stay was not very obvious as one would expect that would affect the availability of unpasteurized milk and its by-products, and perhaps the prevalence of tuberculosis. However, there was found to be a statistically significant variation in the means of males and females, confirming a greater proportion of the hypothesis that 'males are more prone to tuberculosis infection than females'.

Bye and large, it can be concluded that even though some of the factors identified do play some role in the prevalence of tuberculosis in the study area, this role of some of them is however not well pronounced. In particular, duration of stay of the Fulani in a stop-over place does not have significant effect on prevalence. It is probable that nutritional differences among different cultural groups could explain the lack of correlation between duration of stay and TB prevalence. Similarly, distance to the

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DOTS centres or between DOTS centres does not seem to influence prevalence of TB in the study area, a situation which is attributed to the effect of confounders such as differences in population size among centres. Generally however, the findings on the role of age disagree with many previous studies, which indicate that the middle-aged group (21-50) is more prone to the risk of tuberculosis infection.

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CHAPTER SEVEN

THE EFFECT OF ENVIRONMENTAL, BEHAVIOURAL AND SOCIO-ECONOMIC FACTORS AFFECTING THE PREVALENCE OF TUBERCULOSIS

Introduction

The previous chapter discussed the roles of distance, population size, number of health facilities in a settlement, duration of stay in a settlement, and gender and age in the prevalence of tuberculosis. These variables could not provide adequate explanation of TB prevalence. In this chapter, we shall examine the roles of socio-economic, environmental and behavioural factors in the prevalence of tuberculosis in a bid to understand its occurrence better. In trying to address this issue, each of the variables is discussed separately and regression and/or correlation analyses were carried out to show their relationships with tuberculosis prevalence. The environmental factors considered here include 'ever been infected with TB', 'ever suffered other illnesses in the past 12 months' 'limited access to health care' and 'exposure to dust at workplace'. On the other hand, the socio-economic factors considered include work history (whether the respondent has 'ever worked', 'type of work' and 'nature of work' carried out as well as 'duration of work period'), 'type of occupation', 'annual income levels', and 'educational status/literacy level'. 'Dissatisfaction with the state of health', 'ever visited health centre to treat TB', 'ever smoked cigarettes', 'consumption of unpasteurized milk' and 'perception of the causes of tuberculosis' are considered as behavioural. The questionnaire was used to obtain data on these variables and the Analysis of Variance (ANOVA was used to test the relationships and the hypotheses that 'environmental risk factors play significant roles in determining the prevalence of tuberculosis' and 'socio-economic correlates such as work history, occupation, income, literacy level, access to health care and perception, affect the prevalence of TB in the region'.

7.1 Environmental factors

Tables 7.1 and 7.2 show the environmental factors identified during the interview. Table 7.1 shows the distribution of number of persons sleeping in a room. This

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however did not take into cognisance the size of the room, but one would expect this to differ not only between rural and urban settlements, but also between locations, which may be a reflection of cultural settings. Whatever the case might be, the table shows variations among the sample DOTS centres. The highest number of responses is in the group of two to three persons per room in all locations. The least is in the group of six persons per room. What this means is that either the family sizes are small or the culture does not allow parents to sleep in the same room with children older than 3 years. This is particularly true with Muslims who form the greater part of the population in the region. Generally however, overcrowding is not an issue in the study area in relation to TB prevalence. Even where the number of persons sleeping in a room reaches up to four, there is no evidence of overcrowding. Characteristics of the building that indicate occupancy density, room volume and air change rate should have indicated that, but these were not part of the questions asked, particularly because not all respondents could give exact sizes of the rooms as well as the number and sizes of windows, their directions frequency of opening.

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Table 7.1: Number of Persons Sleeping in a Room in Sample Areas

DOTS Centre	Number of Persons sleeping in a room							Sample Size
	1	2	3	4	5	6	>6	
Illela	3	17	6	4	1	0	1	32
Gwadabawa	1	7	13	3	1	1	0	26
Kware	0	4	4	10	4	0	0	22
Sokoto	9	50	20	32	13	5	5	134
Bodinga	0	3	5	4	3	1	0	16
Yabo	0	4	3	2	1	0	0	10
Dogondaji	0	1	2	2	1	2	0	8
Gummi	1	1	3	2	1	0	0	10
Zuru	5	17	6	20	2	1	0	51
Mahuta	0	4	5	0	2	0	0	11
Shanga	0	3	3	0	1	0	0	21
Yauri	3	10	28	17	6	6	2	72
Warra	0	5	2	5	3	3	0	18
Auna	0	1	1	2	1	0	0	5
New Bussa	0	7	4	5	2	2	0	25

Source: Fieldwork, January 2011

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Testing for the statistically significant variation in the number of persons that sleep in a room was carried out using the Analysis of variance (ANOVA). Results (Table 7.3) show no statistically significant difference in the means of the groups, F (15, 89) = 1.117; p = 0.354, since the calculated value is greater than the alpha value of 0.05. This means, crowding is not a risk factor in the prevalence of TB in the study area. On the general note, this study does not lend credence to Clark *et al* (2002)'s work which found an increased risk of two or more cases of TB in a community by 40% with an increase of 0.1 persons per room. It also disagrees with the work of Hill *et al* (2006) that found overcrowding as one of the risk factors of TB but agrees with the work of Chigbu *et al* (2010) who believe that the duration of exposure is more important than the occupancy density.

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Table 7.2: Other Environmental Factors

Health Facility	Ever been infected with TB	Ever Been Diagnosed of lung- or heart r elated disease	Ever Suffered other illnesses in the last 12 months	Family member ever been infected	Ever stayed with TB patient	Exposure of Job to Dust
GH Illela	32	7	14	3	4	11
PHC Gwadabawa	26	1	1	4	3	1
CHC Kware	19	2	8	3	2	5
S/H.Sokoto	57	7	17	9	7	5
GH Bodinga	10	1	3	1	3	2
GH Yabo	1	0	1	0	0	1
GH Dogondaji	8	0	0	1	2	0
GH Gummi	0	2	2	1	1	1
GH Zuru	5	4	13	1	1	0
PHC Mahuta	8	2	3	0	2	8
GH Shanga	18	0	3	2	1	4
GH Yauri	4	0	0	1	1	1
GH Warra	1	0	1	0	0	0
RHC Auna	12	1	8	11	7	5
GH New Bussa	0	0	0	2	2	2
Total	**201 (47.74%)**	**27 (6.41%)**	**74 (17.58%)**	**39 (9.26%)**	**36 (8.55%)**	**44 (10.45%)**

Source: Fieldwork, January 2011

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Table 7.3: The Results of the ANOVA for Number of Persons Sleeping in a Room

		Sum of Squares	df	Mean Square	F	Sig.
one	Between Groups	66.059	15	4.404	1.117	.354
	Within Groups	350.932	89	3.943		
	Total	416.990	104			

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Table 7.2 shows many positive responses to questions on 'ever been infected with TB', 'ever suffered other illnesses in the past 12 months' and 'exposure to dust at workplace' among other environmental factors. The risk of 'ever been infected' had the highest record (47.74%), followed by 'ever suffered other illnesses in the past 12 months' (17.58%) The least effect is found with 'ever been diagnosed of lung or heart-related disease' (6.14%) 'Family member ever been infected', 'ever stayed with a TB patient' and 'exposure of job to dust' showed fairly similar values. This is rather surprising since a person that ever got infected is supposed to have developed some immunity that will prevent re-infection. It is possible that the disease could have developed drug-resistance or the reinfection could have been due to treatment failure due to abscondments. As for the 'ever suffered other illnesses in the past 12 months', such illnesses could have lowered patients' immunity and therefore made them more vulnerable to infection. 'Ever been diagnosed of lung or heart-related diseases poses lower risk perhaps because the diseases were not directly related to tuberculosis.

The findings are in agreement with Sigh *et al* (2005) who reported that contact with infected cases could bring about infection, as well as the work of Hill *et al* (2006) that contact with a family member that had history of infection is a risk factor. The finding also agrees with the work of Kehinde *et al* (2011) that long exposure to tuberculosis could be a risk factor in its infection. In fact according to Daborn *et al* (1996: 927), pulmonary TB due to *M. bovis* is more common among rural dwellers, as a result of inhalation of dust particles or bacteria-containing aerosols shed by infected animals.

Table 7.2 also shows variations among stations. Generally, stations with the highest prevalence (such as Illela, Sokoto and Yauri) also have higher risks of 'ever been infected', perhaps by virtue of their population sizes, except for Zuru and Yauri. Similarly, places with lower prevalence also have lower risks, except for Auna. The role of population size has earlier been stressed and it seems probable that this variable may still be acting as a confounder.

The contributions of individual environmental risk factors were assessed using a multiple regression analysis (Table 7.4) given by Y (Prevalence) = $a_0+X_1a_1+X_2a_2+\ldots\ldots\ldots X_nb_n$), where a_0 is a constant, X_1 is 'ever been infected', X_2 is 'ever been diagnosed of lung-related disease, X_3 is 'ever suffered illness in the last 12 months', X_4 is 'family member ever been infected', X_5 is ever stayed with a TB patient', and X_6 is exposure of job to dust'. The essence was to identify the relative contributions of each of the variables in the prevalence of tuberculosis in the study area. The results indicate that 'ever been diagnosed of lung and heart-related diseases' seems to have the highest contribution in the model (B=4.943), followed by 'ever stayed with a TB patient' (B=2.213) and then 'family member ever been infected with TB' (B=1.411). In this analysis, the role of 'ever been diagnosed of lung or heart-related diseases that was hitherto not clearly spelt out in the raw data now becomes evident.

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Table 7.4: The Results of the Regression Analysis for Environmental Risk Factors

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	66.551	44.037		1.511	0.169
	Everinfect[1]	4.943	3.053	0.630	1.619	0.144
	Everdiagn[2]	20.237	38.454	0.400	0.526	0.613
	Eversuffer[3]	1.411	14.815	0.066	0.095	0.926
	Familyme[4]	2.213	27.568	0.059	0.080	0.938
	Everstyed[5]	-6.616	40.719	-0.118	0-.162	0.875
	Exposudu[6]	-18.168	10.655	-0.485	-1.705	0.127

a. Dependent Variable: Prevalence

[1]Ever been infected with TB; [2]Ever been diagnosed of lung and heart-related diseases; [3]Ever suffered illness in the last 12 months; [4]Family member ever been infected; [5]Ever stayed with a TB patient; 'Exposure of job to dust'

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The finding agrees with many of the studies carried out in this area. Notably, the works of Lienhardt *et al* (2003) who assert that a high risk of TB infection exists among contacts of TB cases, which increases with the intimacy of contact with the case; Tornce *et al* (2004) who argue that persons living in the household of a TB patient are at high risk of becoming infected and developing the disease; Singh *et al* (2005) who believe that contact with a sputum-smear positive patient and the occurrence of positive tuberculin test are correlated; Nakaoka *et al* (2006) who said exposure to adults by children of smear-positive TB is the most important risk factor for transmission within the household; Hill *et al* (2006) who stress that overcrowding and a history of household exposure to a known TB case are risk factors; Sororg, *et al* (2011) who believe that increased risk of TB infection might be as a result of closer contact between infected family; and Kehinde *et al* (2011) who believe that longer exposure to TB index case is responsible for greater infection.

Testing of the hypothesis that says 'environmental factors play significant roles in determining the prevalence of tuberculosis' was carried out using the Analysis of Variance on data in Table 7.2 for the variables. The results, presented in Table 7.5, indicate no statistically significant difference between the variables considered, $F(19, 70) = 1.245$, $p = 0.249$ at 0.05 significance level since the p-value is greater than the alpha value of 0.05. We therefore reject our hypothesis that 'environmental risk factors play significant roles in determining the prevalence of tuberculosis'.

Again, the finding disagrees with the works of Lienhardt *et al* (2003), Tornce *et al* (2004), Singh *et al* (2005), Nakaoka *et al* (2006), Hill *et al* (2006), Sororg, *et al* (2011) and Kehinde *et al* (2011)

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Table 7.5: The Results of the Analysis of Variance on Environmental Factors

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	66.299	19	3.489	1.245	0.249
Within Groups	196.201	70	2.803		
Total	262.500	89			

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7.2 Behavioural factors

The behavioural variables (Table 7.6) were also obtained from the affirmative responses of the TB patients interviewed and they include 'health dissatisfaction', 'ever smoked cigarettes', 'ever grazed animal in the fields',' ever slept in the mist of animals', 'consumption of unpasteurized milk and its by-products'. The table shows that 'ever visited a health centre to treat TB' and 'consumption of unpasteurized milk and its by-products' pose similar risk (34.95%) which is the highest among the factors. These are followed by 'ever smoked cigarettes' (27.88%) and the least risk is with 'sleeping in the midst of animals' (2.21%). All these are variables known to cause or enhance tuberculosis infection (Lam *et al*, 2004; Arcavia, 2004; Ariyothai *et al*, 2004; Beals, 2007; Lin *et al*, 2009 and Chigbu *et al* 2010). This supports the view that availability of unpasteurized milk and its by-products influences the prevalence of TB in the region, and by extension, also supports the earlier finding on temporal variation that seasonal migration affects the prevalence of TB.

From Table 7.6 'sleeping in the midst of animals' does not seem to play a significant role in the prevalence of tuberculosis. In fact, 'sleeping in the midst of animals' recorded the least response, while 'ever been infected' and 'consumption of unpasteurized milk and its by-products' had the highest response. The high value for 'consumption of unpasteurized milk and its by-products' may be a function of their availability at different places as the Fulani migrate, which reinforces the earlier finding that human mobility plays a role in the prevalence of TB in the study area. On the contrary, least responses for 'sleeping in the midst of animals' is indicative of few cases of zoonotic infection of tuberculosis between humans and animals as a result of living within the same environment or through perspiration. This finding does not agree with Ayele *et al* (2004)'s and Shitaye *et al* (2007)'s views that close contacts with infected animals could represent one of the main causes of tuberculosis infection for humans.

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Table 7.6: Behavioural Factors

Health facility	Ever visited health centre to treat TB	Ever smoked cigarettes	Sleeping in midst of animals	Consumption of fresh milk
GH Illela	17	12	0	18
PHC Gwadabawa	3	9	0	9
CHC Kware	2	8	0	0
S/H.Sokoto	20	8	0	2
GH Bodinga	0	4	0	5
GH Yabo	0	0	0	1
GH Dogondaji	3	2	0	6
GH Gummi	10	2	0	1
GH Zuru	15	0	0	2
PHC Mahuta	2	2	0	5
GH Shanga	2	6	0	7
GH Yauri	0	1	1	3
GH Warra	1	1	0	1
RHC Auna	7	7	3	18
GH New Bussa	7	1	1	1
Total	**79 (34.95%)**	**63 (27.88%)**	**5 (2.21%)**	**79 (34.95%)**

Source: Fieldwork, January 2011

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Table 7.6 also shows variations among the DOTS centres. Those with the highest prevalence (Illela, Sokoto and Zuru) have the highest risk of infection with consumption of unpasteurized milk and ever visiting a health centre to treat TB, perhaps by virtue of their population size. It is apparent therefore that the roles of the perceived behavioural factors in the prevalence of tuberculosis vary among stations and there might be some sort of synergy among the factors as their respective roles were not pronounced in some stations.

A Multiple Regression Analysis was carried out to determine the statistical significance of the variables where Prevalence (Y) = $a_0+X_1a_1+X_2a_2+X_3a_3+X_4a_4$. In this model, X_1 = 'ever visited a health centre to treat a disease', X_2 = 'ever smoked cigarettes', X_3 = 'sleeping with animals' and 'X_4= 'consumption of unpasteurized milk'. Result presented in Table 7.7 shows that sleeping in the midst of animals has the highest contribution in the prevalence of tuberculosis among the behavioural risk factors, followed by ever been a cigarette smoker and then having ever visited a health centre to treat a disease contrary to what the raw data shows. Consumption of unpasteurized milk seems to have a negative contribution. The result tallies with the assertions of many scholars (Dye *et al*, 2009; Erahl *et al*, 2009; Chigbu *et al*, 2010; Lopez De Fede *et al*, 2008; Muniyandi *et al*, 2008; and Mackenbach *et al*, 2008). It agrees with the works of Daborn *et al* (1996) who found that TB infection could be due to bacteria-containing aerosols shed by infected animals, and the works of Alhaji *et al* (1977), Cosvi *et al* (1998), Ayele *et al* (2004), Cadmus *et al* (2006), Thoen *et al* (2006), Shitaye *et al* (2007), Yumi *et al* (2007), Ofukwu *et al* (2008), Beals (2007) and Abubakar *et al* (2011) who suggest the possibility of contracting a zoonotic infection between humans and animals due to staying with the animals. Generally, the results agree with the works of Lonnroth *et al* (2009), Yim *et al* (2010), Erahl *et al* (2009) and Dye *et al* (2009), all of which argued that infection with tuberculosis results from a complex interaction between the social and environmental variables, the host and the pathogen. At this juncture, it is important to stress the need for a holistic approach to the study of the risk factors due to their complex interactions.

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Table 7.7: The Results of the Regression Analysis for Behavioural Factors

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	59.415	42.617		1.394	0.193
	Ever visited a health centre to treat TB	10.673	4.331	0.583	2.464	0.033
	Ever smoked cigarettes	12.556	10.214	0.395	1.229	0.247
	Sleeping in the midst of animals	31.474	40.272	0.212	0.782	0.453
	Consumption of fresh milk	-14.360	7.383	-0.685	-1.945	0.080

a. Dependent Variable: Prevalence

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Analysis of Variance was carried out to test the significance of the behavioural factors in affecting the prevalence of tuberculosis in the study area. The results presented in Tables 7.8 indicate no statistically significant difference in the means of the variables considered, F (15, 44) =1.397; p=0.191, at 0.05 significance level since the p-value is greater than the alpha value of 0.05. This is further supported by the significantly lower *Between Group Variation* than the *Within Group Variation***,** thus implying lack of a statistically significant difference between the groups. In other words, behavioural factors play no role in the prevalence of tuberculosis in the study area.

The finding tallies with the assertions of many scholars such as Ayele *et al* (2004), Thoen *et al* (2006) and Abubakar *et al* (2011), for suggesting that consumption of unpasteurized milk is one of the sources of infection for humans. It is however in disagreement with the works of Daborn *et al* (1996), Chigbu *et al*, 2010; Lam *et al*, 2004, Arcavia, 2004, Ariyothai, *et al* 2004, Singh *et al*, 2005, Lin *et al*, 2009 and Ekrakene *et al*, 2010 for attributing infection to dusty environment and tobacco/cigarette smoking. However, it agrees with the works of Lonnroth *et al* (2009), Yim *et al* (2010), Erahl *et al* (2009) and Dye *et al* (2009), all of which argued that infection with tuberculosis results from a complex interaction between the environment, social and environmental variables, the host and the pathogen. At this juncture, I would want to subscribe to the need for a holistic approach to the study of the risk factors due to their complex interactions.

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Table 7.8: The Results of the Analysis of Variance for Behavioural Factors

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	24.197	15	1.613	1.397	0.191
Within Groups	50.803	44	1.155		
Total	75.000	59			

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7.3 Socio-demographic factors

The variables considered here (Table 7.9) include marital status, ethnicity, work history (whether ever worked, type of work, nature of work and duration of work period), type of occupation, income and literacy levels, perception and access to health services. However, gender and age were discussed in Chapter Six with data obtained from records of TB cases and need not be discussed here.

7.3.1 Ethnicity

Table 7.9 shows dominance of the *Hausa* and *Fulani* ethnic groups, which is not surprising since these ethnic groups constitute the majority in the region. In all the northernmost DOTS centres (Illela, Gwadabawa, Kware, Sokoto, Bodinga, Yabo, Dogondaji and Gummi), these ethnic groups predominate. As one moves southwards, the predominance declines and gives way to other ethnic groups. This is observed for Yauri, Zuru, Mahuta, Auna and New Bussa DOTS centres. This trend may have implications on the type of cultural beliefs and practices across the region, which may in turn affect the prevalence of tuberculosis.

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Table 7.9: Ethnicity and Marital Status Variables

Health Facility	Ethnicity			Marital Status	
	Hausa	**Fulani**	**Others***	**Married**	**Single**
Illela	30	2	0	28	4
Gwadabawa	18	8	0	24	2
Kware	19	2	1	17	5
Sokoto	79	23	32	99	35
Bodinga	13	3	0	13	3
Yabo	7	3	0	7	3
Dogondaji	6	1	1	8	0
Gummi	7	1	1	8	2
Zuru	17	11	24	39	12
Mahuta	3	1	7	10	1
Shanga	7	5	9	16	5
Yauri	29	7	36	63	9
Warrah	12	3	3	12	6
Auna	1	1	3	5	0
N/Bussa	2	13	12	21	4
Total	**250 (54.11%)**	**84 (18.18%)**	**128 (27.70%)**	**370 (80.26%)**	**91 (19.74%)**

* include Yoruba, Zabarma, Dakarkari, Gungawa, Batude, Fakai, Kukum, Shangame, Ibibio, Baáre, Nupe. Kambari and Bissa

Source: Fieldwork, January 2011

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The statistical significance of the variation in ethnicity factors was tested using the Analysis of Variance on the three categories of ethnic groups (Table 7.10). This did not however show any statistically significant difference in the means of ethnicity variables, F (21,23) = 1.492, p= 0.175, since the p-value is greater than the alpha value at 0.05 significance level This is in spite of the slightly greater *Between Group Variation* than the *Within Group Variation* that suggests the likelihood of statistical significance difference between the groups. This finding refutes the hypothesis that socio-demographic variables (such as ethnicity) play a role in the prevalence of tuberculosis in the region. The contention is that cultural differences (which are inherent in ethnicity characteristics) affect health and health behaviour practices (Gesler, 2002), as indicated by the work of Hill *et al* (2006) as a risk factor, is not substantiated. Ethnicity in Nigeria may explain cultural backgrounds and practices, which may have important bearings on the general hygiene and health-seeking behaviours. These could in turn be affected by literacy and income levels. However, the lack of significant difference in the means of the variables considered could be explained by the fact that some of these factors are common among the rural dwellers regardless of the ethnic group. Poverty level, low educational status, poor hygiene and health-seeking behaviours are some of the factors that could explain the lack of statistically significant variation in the prevalence of tuberculosis in the study area among the ethnic groups.

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Table 7.10: The Results of the Analysis of Variance for Ethnicity Variables

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	17.300	21	0.824	1.492	0.175
Within Groups	12.700	23	0.552		
Total	30.000	44			

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7.3.2 Marital status

Table 7.9 gives the marital status variables obtained in the interviews. This shows a preponderance of married patients over the singles. This is observed for all stations. Generally, married couples constitute 80.26% of the respondents while the singles constitute 19.74%. It is possible that married couples are more prone due to their ages than singles, who could be children and the elderly. It could also be that this group is more exposed because of their greater contacts, particularly when their spouses happen to be the index cases. Whatever the case might be, this situation has implications for household contacts and invariably higher prevalence of tuberculosis in the region.

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A test of the statistically significant difference between the groups was done using the test of mean difference (t-test). The result (Table 7.11) showed a statistically significantly difference, t=4.008; p= 0.001, among the marital status variables since the p-value is lower than the alpha value at 0.05 significance level under 14 degrees of freedom. The findings show that marital status matters among the socio-demographic factors in the prevalence of tuberculosis in the region and therefore reinforces the role of being married as observed in Table 7.9. This agrees with the work of Rafiza *et al* (2011) who observed that being married, particularly when living with an index case, faces a high risk of TB infection.

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Table 7.11: The Results of the Test of Mean Difference (t-test) for Marital Status Variables

Paired Differences							
			95% Confidence Interval of the Difference				
Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
1.86000E1	17.97538	4.64122	8.64557	28.55443	4.008	14	0.001

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7.4 Work history

This has to do with whether the respondent has ever worked and if so, what was the type (skilled or unskilled) and nature of work (paid or unpaid), and the duration of the work period? Here, skilled work refers to any job with a certificate recognized by the profession while unskilled is the contrary. Data on these variables are presented in Table 7.12. The table shows that the majority of the respondents (320) interviewed have not worked before as against those who have had some work history (131). Also, across the board, even among those who have worked, the unskilled (103) were greater in number than the skilled (28) workers and they constituted more than 77.66% (52) of unpaid jobs as against the paid jobs (less than 40%). Similarly, the duration of the work period has varied according to stations but the general trend is that most of those who worked did so within the past one to ten years. These results have implications on the prevalence of tuberculosis in the area because they are directly related to income which may affect nutrition and the ability to access and utilize health care services. In other words, work history can help to explain the prevalence of tuberculosis in the area. Even for the urban areas where greater prevalence is recorded like Sokoto and Yauri, those who 'ever worked' were either 'unskilled' or 'unpaid'. To analyse the relationships between each of the variables and TB prevalence, a test of Mean Difference (t-test) was carried out on each of the variables. The results will be discussed for each of the variables under the following sub-headings.

7.4.1 Ever worked

It is believed that working now or ever worked could affect the prevalence of TB because working, particularly with pay, could be a measure of income, and invariably the ability to access health facilities or afford drugs and good nutrition. Table 7.12 shows high prevalence of tuberculosis in most centres among those that have never worked (70.95%), except for Kware, Yabo and Auna health facilities. This finding is in consonance with the work of Oboku *et al* (2012) that found unemployment as a significant risk factor in tuberculosis infection, as well as the work of Ogboi *et al* (2010) that associated poor socio-economic status to poor education and poor knowledge of tuberculosis, with its antecedent risk of infection, dissemination and

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poor access to healthcare. The importance of having a paid employment has also been stressed by Gatrel (2006) in having direct impact upon health.

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Table 7.12: Work History

DOTS Centre	Sample drawn	Ever Worked									
		Type of Work		Duration of Work				Nature of Work		Yes	No
		Skilled	Unskilled	1-10 yrs	11-20yrs	21-30yrs	>30yrs	Unpaid	Paid		
Illela	32	2	7	5	3	10	0	9	0	9	23
Gwadab	26	4	6	3	6	1	0	8	2	10	16
Kware	22	3	2	2	2	0	1	3	2	5	17
Sokoto	134	8	27	21	9	3	2	31	4	35	99
Bodinga	16	1	4	2	3	0	0	2	3	5	11
Yabo	10	0	3	3	0	0	0	0	3	3	7
D/Daji	8	0	0	0	0	0	0	0	0	0	8
Gummi	10	1	2	1	2	0	0	3	0	3	7
Zuru	51	4	11	4	8	2	1	8	7	6	12
Mahuta	11	0	4	1	2	1	0	3	1	2	8
Shanga	21	1	4	2	3	0	0	2	3	1	5
Yauri	72	3	22	8	11	4	2	7	18	3	17
Warra	18	0	4	3	2	0	0	0	4	0	5
Auna	5	0	2	2	0	0	0	1	1	2	0
N/Bussa	25	1	5	2	3	1	0	2	4	3	17
Total	461	**28**	**103**	**58**	**54**	**13**	**6**	**79**	**52**	**131**	**330**
		(21.38%)	**(78.62%)**	**(44.27%0**	**(41.22%)**	**(9.92.79%)**	**(4.58%)**	**(60.30%)**	**(39.69%)**	**(29.04%)**	**(70.95%)**

Source: Fieldwork, January 2011

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The role of ‘never worked’ as a risk variable for TB was proved further using the t-test and the result (Table 7.13) shows a statistically significant difference in the means of the ever worked variables. (t=-2.776; p=0.015) since the p-value is lower than the alpha value at 0.05 significance level under 29 degrees of freedom. From Table 7.12, those who had never worked have the highest contribution to the prevalence (70.95%). We therefore accept our hypothesis which says ‘work history plays a role in the prevalence of tuberculosis’, since working connotes earnings to take care of one’s health. Lack of work implies little or no income, and thus more susceptibility to diseases due to poor diet and medication.

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Table 7.13: The Results of the Test of Mean Difference (t-test) for 'Ever worked'

Paired Differences							
			95% Confidence Interval of the Difference				
Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
-1.10000E1	15.34834	3.96292	-19.49963	-2.50037	-2.776	14	0.015

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7.4.2 Nature of work

Data on this variable (Table 7.12) still showed that the unpaid respondents (60.30%) constitute the majority. What is not clear however, is the condition under which the skilled labour is operated. It could be that the type of labour engaged in by the respondent exposures him/her to index cases (as in the case of health workers) or to dusty environments as in the case of farmers or even to crowded conditions, as in the case of market traders.

The t-test was carried out to test the significance of the relationship and the result presented in Table 7.14 showed no statistically significant difference in the means of the test variables since the calculated p-value (t=0.840, p=0.415) is greater than the tabulated alpha value under 14 degrees of freedom at 5% significance level. Thus the nature of work one does is not important in the prevalence of tuberculosis in the study area. This does not support the high prevalence among the unpaid workers as compared to the paid workers. We therefore reject the assertion that nature of work done affects the prevalence of TB. This finding therefore agrees with the work of Hill *et al* (2006) which found household poverty to contribute to the development of tuberculosis and the work of Ogboi *et al* (2010) who demonstrated the role of poor socio-economic status in contributing to TB prevalence. The possible relationship of this variable with ever having an employment had earlier been stressed in the previous paragraphs. The finding therefore confirms our hypothesis on socio-economic correlates that signifies type of work as one of the variables that influence the prevalence of tuberculosis.

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Table 7.14: The Results of the Test of Mean Difference (t-test) for Nature of Work

Paired Differences							
			95% Confidence Interval of the Difference				
Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
1.80000	8.29974	2.14298	-2.79624	6.39624	0.840	14	0.415

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7.4.3 Type of work

Data on this variable are presented in Table 7.12. This factor could indirectly impact on the prevalence of tuberculosis in the sense that earned income is a measure of ability to purchase drugs, have good nutrition as well as pay for transport to access health care. Unskilled labour is synonymous with low income and invariably, low socio-economic status and increased exposure to the disease. It has in fact been observed that low socioeconomic status is most strikingly associated with high rates of infectious and parasitic diseases (Syme *et al*, 1976). The table however shows that unskilled workers are more affected by the prevalence of tuberculosis than the skilled.

The significance of this finding was further tested using the t-test. The result (Table 7.15) showed a statistically significant difference between the means of the variables (t=-3.221; p=0.006) at 0.05 significance level since the calculated p-value is lower than the alpha value under 14 degrees of freedom. Based on these results, we accept the hypothesis that includes type of work as one of the factors playing a significant role in influencing TB prevalence. The finding is therefore in agreement with the general belief that low socio-economic status is most strikingly associated with high rates of infectious and parasitic diseases (Syme *et al*, 1976; Ogboi *et al*, 2010). It also agrees with the works of Gupta *et al* (2011) that found significant association of TB with labourers (44%) who do not possess any professional skill, followed by white-collar workers (27%), who are supposed to be professionals. This is obvious since lack of skill affects employment and earnings, and invariably ability to afford good nutrition and medication. It is also in consonance with the works of Hill *et al* (2006) that associated household poverty to the development of tuberculosis. On the contrary, it disagrees with the work of Itah and Udofia (2005) who reported high incidence of tuberculosis among traders and health workers, perhaps by virtue of their close contacts with index cases.

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Table 7.15: The Results of the Test of Mean Difference (t-test) on Type of Work

Paired Differences							
			95% Confidence Interval of the Difference				
Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
-5.00000	6.01189	1.55226	-8.32928	-1.67072	-3.221	14	0.006

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7.4.4 Duration of work period

Table 7.12 shows that those who have worked for a period of 1-10 years constitute 44.27%; those with 11-20 years work duration have 41.22%; those with 21-30 years have 9.92% and those with above 30 years duration of work have 4.58%. It is believed that duration of work period, particularly when it goes with pay may be a determinant of infection. If the work period is in an environment where one gets greater exposure to the disease like the case of health workers or industrial/agricultural workers that work in dusty environment, he or she gets infected with the disease. Thus, longer work period may be synonymous with longer exposure to the disease. However, longer work period could also mean a more steady income to take care of health-related conditions. It may also mean the longer the work period, the greater the experience (and promotion) and the greater would be the earning for better standard of living and access to health service. This is in consonance with the works of many scholars that long term exposure could be a risk factor in the prevalence of tuberculosis. Case examples are those of Rafiza *et al* (2011) that reported high association of TB with duration of employment and Kehinde *et al* (2011) who also detected more TB cases among those hospital workers that spent longer period in their units, indicating longer exposure. On the contrary, shorter work period may indicate lesser exposure but at the same time lesser pay to take care of the infection.

An examination of the statistical significance of this relationship was carried out using the analysis of variance. The results (Table 7.16) indicated a statistically significant difference between the periods of work, F (11, 48) = 2.772, p= 0.007, since the calculated p-value is less the alpha value at 0.05 significance level. Similarly, the *Between Group Variation* is significantly greater than the *Within Group Variation*, thus affirming the statistically significant difference between the groups. This finding affirms the notion that duration of work plays a major role in influencing the prevalence of tuberculosis in the study area. From Table 7.12, those with least duration of work have higher prevalence than the rest of the group. This may signify that they have least experience in the job and thus lower pay to take care of the disease.

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Table 7.16: Results of Analysis of Variance for Duration of Work Period

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	29.137	11	2.649	2.772	0.007
Within Groups	45.863	48	0.955		
Total	75.000	59			

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7.5. Type of occupation

Data on the type of occupation that the respondents are engaged in are presented in Table 7.17. These were categorized as ‘civil servants’, ‘business men’, ‘farmers’ and ‘others’. Business here includes any commercial venture that includes trading, buying and selling, consultancy, entrepreneurship, etc, while others include full-time house wives and artisans. The table shows that the greater number of respondents are ‘civil servants’ (31.88%), followed by farmers (26.89%), then ‘others’ such as full-time houses wives and artisans (20.82%) and finally business men (19.52%). There are however variations among stations. Farmers constitute the majority in Sokoto DOTS centre for instance. Generally, the type of occupation does not seem to associate with tuberculosis prevalence in any particular health centre. The high percentage of ‘civil servants’ could be explained in terms of their income levels. It is possible that the majority are low-income earners, particularly labourers and messengers, which will affect their ability to afford good nutrition and be less susceptible to the disease. It is therefore pertinent that more detailed studies on the relationship between civil servants’ income and their susceptibility to tuberculosis infection need to be carried out. It could also be due to their higher number in more urbanized DOTS centres. Interestingly from the table, business men have the least risk of getting infected (19.52%), perhaps by virtue of their possible higher income level, their level of interaction notwithstanding.

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Table 7.17: Occupation of Respondents

Health Facility	Type of Occupation			
	Civil Servant	**Business man**	**Farmer**	**Others**
GH Illela	3	5	15	9
PHC Gwadabawa	9	5	7	5
CHC Kware	12	6	2	2
SH Sokoto	49	28	26	31
GH Bodinga	3	4	5	4
GH Yabo	5	1	4	0
GH D/Daji	4	1	2	1
GH Gummi	6	1	3	0
MGH Zuru	12	13	11	15
PHC Mahuta	6	1	4	0
GH Shanga	2	2	13	2
GH Yauri	27	20	17	8
GH Warra	3	3	11	1
GH Auna	3	0	1	1
GH New Bussa	5	0	3	17
Total	**147 (31.88%)**	**90 (19.52%)**	**124 (26.89%)**	**96 (20.82%)**

Source: Fieldwork, January 2011

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The role of occupation on tuberculosis prevalence was examined using the Multiple Regression Analysis. The regression model can be written as: $Y = a_0+X_1a_1+X_2a_2+X_3a_3+X_4a_4$ where Y is the prevalence, a_0 is a constant, X_1 is Civil servant, X_2 is Business man, X_3 is Farmer and X_4 is other occupations. The results presented in Table 7.18 however show farming activity has the highest contribution (4.023) to the prevalence followed by other activities and then business. This high contribution could be attributed to exposure of job to dust, travel and interaction as mentioned earlier. It may also be indicative of a possible synergy that could exist between this variable and other socio-economic risk factors such as income, which is directly related to type of occupation. The role of income in affecting prevalence will be discussed later, but we can infer that income is a measure of relative affordability of access to health care facilities, purchase of drugs and maintenance of good nutrition, which have direct bearings on health generally, and tuberculosis infection in particular.

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Table 7.18: The Results of the Regression Analysis on Type of Occupation

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-1.475	0.970		-1.520	0.160
	Civil servant	3.662	0.153	0.378	23.977	0.000
	Business	3.305	0.275	0.222	12.013	0.000
	Farmer	4.023	0.159	0.236	25.338	0.000
	Others	3.491	0.108	0.250	32.382	0.000

a. Dependent Variable: Prevalence

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Testing the statistical significance of this variable on tuberculosis prevalence was done using the analysis of variance and result presented in Table 7.19 showed no statistically significant difference in the means of the variables considered, F (20, 39) = 1.480, p= 0.145, as the calculated p-value is greater than the alpha value at 0.05 significance level. The *Between Group Variation* is also lower than the *Within Group Variation***,** thus implying lack of a statistically significant difference between the groups. Thus, type of occupation does not affect the prevalence of tuberculosis in the study area. We therefore reject the hypothesis that type of occupation, as one of the socio-economic correlates that affects the prevalence of TB in the study area. This finding is at variance with the work of Itah and Udofia (2005) that found traders with the highest incidence of tuberculosis in their study area.

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Table 7.19: The Results of the Analysis of Variance on Type of Occupation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32.363	20	1.618	1.480	0.145
Within Groups	42.637	39	1.093		
Total	75.000	59			

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7.6 Income level

This variable was obtained from responses of respondents on their annual income and the data are presented in Table 7.20. The table shows that the income levels in the study area are generally low (below ₦50, 000 per annum) or zero (44.47% of respondents). In fact if we consider ₦50, 000 per annum, this constitutes 79.39% of the respondents. Similarly, two centres of high tuberculosis prevalence (Illela and Sokoto) also have the lowest annual income (₦1, 000-₦50, 000) or zero income. The least risk of infection is found with income levels greater than ₦101, 000 per annum (7.8%). These observations are not out of place since the region is known to have the highest poverty index in the country. Little income or lack of it is also indicative of the purchasing power of the people, which translates to their ability or otherwise, to access health facilities, purchase drugs and afford good nutrition food, as well as live in better housing devoid of over-crowding.

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Table 7.20: Income Levels of Respondents

Health Facility	No income	1,000-50,000	51,000-100,000	101,000-150,000	>150,000
Illela	23	5	3	0	1
Gwadabawa	13	10	3	0	0
Kware	15	7	0	0	0
Sokoto	56	55	11	8	8
Bodinga	4	7	3	2	0
Yabo	7	2	1	0	0
Dogondaji	7	1	0	0	0
Gummi	5	3	2	0	0
Zuru	5	25	8	2	1
Mahuta	7	2	2	0	0
Shanga	5	11	3	1	0
Yauri	25	23	15	7	2
Warra	8	6	1	1	2
Auna	3	1	0	0	1
N/Bussa	22	3	0	0	0
Total	**205(44.47%)**	**161(34.92%)**	**55(11.27%)**	**21 (4.55%)**	**15 (3.25%)**

Source: Fieldwork, January 2011

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This relationship of variable with tuberculosis prevalence was further examined using the Multiple Regression Analysis and results presented in Table 7.21. The regression model is represented by $Y = a_0+X_1a_1+X_2a_2+X_3a_3+X_4a_4+X_5b_5$ where Y is the prevalence, a_0 is a constant, X_1 is the income level 1,000-50,000, X_2 is the income level 51,000-100,000, X_3 is the income level 101,000-150,000, X_4 is the income level greater than 150,000, while X_5 represents lack of income. Thus, income level 1,000-50,000 has the highest contribution. This level of income confirms the general belief that low income contributes to high prevalence of tuberculosis.

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Table 7.21: The Results of the Regression Analysis on Income Levels

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.247	2.952		0.422	0.683
	No income	2.991	0.230	0.341	13.012	0.000
	1,000-50,000	4.438	0.356	0.523	12.464	0.000
	51,000-100,000	5.733	1.193	0.210	4.807	0.001
	101,000-150,000	-1.569	2.489	-0.033	-0.631	0.544
	>150,000	2.892	2.549	0.049	1.135	0.286

a. Dependent Variable: Prevalence

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Further testing of the statistical significance of the relationship of this variable with tuberculosis prevalence using the Analysis of Variance (ANOVA) (Table 7.22) indicated a statistically significant difference among the variables considered, F (17, 57) = 5.407, p = 0.00 since the p-value is lower than the alpha value at 0.05 significance level. that of the five levels. In other words, income is important in affecting the prevalence. This is supported by Table 7.18 which shows highest prevalence among those with no income, followed by those with 1,000-50,000 income per annum. This confirms the belief that poverty translates to inability to pay for health services, better housing, good nutrition and hygiene, leading to poor health situation. The finding agrees with the views of Ogboi *et al* (2010) who have it that poor socio-economic status, particularly when associated with poor education could be a risk factor in tuberculosis infection. This is more so if we bear in mind that socio-economic risk factors are intricate and their effects on tuberculosis prevalence may depend on the society, its belief system and cultural practices. The finding also agrees with the works of Syme *et al* (1976), Lienhardt *et al* (2005), Hill *et al* (2006), Gustafson *et al* (2004), Nwacholor and Thomas (2000) Shetty *et al* (2006) who found poor income as a risk factor in tuberculosis prevalence. It however disagrees with the work of Tornce *et al* (2004) who reported no association between family income and TB prevalence in their study.

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Table 7.22: The Results of the Analysis of Variance (ANOVA) on Income Levels

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	92.589	17	5.446	5.407	0.000
Within Groups	57.411	57	1.007		
Total	150.000	74			

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7.7 Literacy level

Education is believed to impact on the prevalence of tuberculosis in that the higher the literacy level, the higher might be the knowledge about the disease as well as the income for those employed. Knowledge about tuberculosis is important in health-seeking behaviour, particularly as it relates to delays in seeking treatment. Similarly, income accrued from employment due to higher literacy level indirectly affects prevalence through its effect on ability to purchase drugs and access health centres, as well as to maintain good nutrition, all of which might affect infection and the progression of the disease. Literacy here refers to the ability to read (with understanding) acquired through Western system of education (with or without a certificate). It therefore entails going through different levels of Western education obtainable within the country. Data on this are presented in Table 7.23 which shows that those with 'no formal education' constitute the majority (35.57%) of the respondents.

Only Sokoto, Yauri and Shanga centres have respondents that have been to the University. Not only that, the table shows that stations with higher prevalence also have more patients with 'no formal education' as is the case with Sokoto, Illela and Zuru centres, except for Yauri centre which has a relatively smaller number. This is no surprise since this region is reported to have the lowest literacy level in the country. Little wonder then that the majority of the respondents do not have formal education. This low literacy situation is most likely to influence the prevalence of tuberculosis in the region through its various effects on knowledge about the disease, health-seeking behaviour, hygiene practices and likely salaried income. "No formal education" tallies with the general belief that illiteracy could be a correlate of tuberculosis prevalence. This is in consonance with the work of Obuku *et al* (2012) that found non-formal education as a determinant of poor TB knowledge, and consequently, a risk to tuberculosis infection and the work of Lien *et al* (2009) that reported significant TB test positivity with education level lower or equal to high school and pre-university level.

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Table 7.23: Literacy Levels of Respondents

Health Facility	No formal Education	Primary	Secondary	Polytechnic/ COE.	University	Others
Illela	21	4	6	0	0	0
Gwadabawa	9	5	7	0	0	6
Kware	1	4	7	2	0	8
Sokoto	44	27	25	9	3	26
Bodinga	6	3	1	0	0	6
Yabo	6	1	1	0	0	2
Dogondaji	3	1	1	1	0	2
Gummi	7	1	2	0	0	0
Zuru	24	7	8	0	0	12
Mahuta	8	0	2	0	0	0
Shanga	6	3	3	0	1	8
Yauri	18	8	17	1	1	17
Warra	5	3	6	0	0	6
Auna	2	1	1	0	0	1
New Bussa	11	3	6	1	0	4
Total	**170 (39.25%)**	**70 (15.18%)**	**93 (20.17%)**	**14 (3.03%)**	**5 (1.08%)**	**98 (21.25%)**

Source: Fieldwork, January 2011

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The relationship of this variable with tuberculosis prevalence was examined using the Multiple Regression Analyses with the regression model as: $Y = a_0+X_1a_1+X_2a_2+X_3a_3+X_4a_4+X_5a_5+ X_6a_6+ X_7a_7$ where Y is the prevalence, a_0 is a constant, X_1 is the Nursery, X_2 is the Primary, X_3 is the Secondary, X_4 is the COE/Polytechnic, X_5 is the University, X_6 is Others and X_7 represents No formal education.. The results (Table 7.24) indicate a low positive contribution of 'university' level of literacy, followed by primary level and then 'nursery' level. This agrees with our general thinking that the higher the level of education, the higher could be the levels of awareness about the disease and income, and consequently, the lower will be the rate of tuberculosis prevalence. The finding is in agreement with the works of Lien *et al* (2009) that lower education level could be a risk factor in tuberculosis infection.

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Table 7.24: The Results of the Regression Analysis for Literacy Level

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-4.506	3.385		-1.331	0.225
	Nursery	4.628	3.142	0.032	1.473	0.184
	Primary	-1.203	2.174	-0.065	-0.553	0.597
	Secondary	5.828	1.052	0.322	5.541	0.001
	PolyCOE	4.288	3.371	0.082	1.272	0.244
	University	13.475	6.668	0.091	2.021	0.083
	Others	4.394	1.029	0.261	4.271	0.004
	None	4.119	0.566	0.370	7.283	0.000

a. Dependent Variable: Prevalence

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The statistical significance of the relationship of literacy level with tuberculosis prevalence was tested using the analysis of variance (ANOVA). Data were collapsed into three categories; 'No formal education'/'Others'; 'Primary'/'Secondary'; and 'Tertiary' (Table 7.25). The results (Table 7.26) show a statistically significant difference between literacy levels, F (20, 26) =5.152, p = 0.000. Also, the fact that the *Between Group Variation* is significantly greater than the *Within Group Variation* implies the existence of a statistically significant difference between the groups. Therefore, literacy level is important in the prevalence of tuberculosis in the study area. The highest prevalence is among those with 'no formal education'/'others' group, followed by 'primary' and 'secondary' education. The lowest is recorded among those with tertiary education. Therefore literacy level is one of the factors that affect the prevalence of tuberculosis in the region. The finding is in agreement with the general belief that the higher the level of education, the higher could be the levels of awareness about the disease as well as the income, and consequently, the lower will be tuberculosis prevalence. It is also in agreement with the works of Lien *et al* (2009) who posit that lower education level could be a risk factor in tuberculosis infection. This also confirms our hypothesis that literacy level affects the prevalence of tuberculosis in the study area.

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Table 7.25: Collapsed Literacy Levels of Respondents

Health Facility	No formal Education/Others	Primary/Secondary	Tertiary
Illela	21	10	0
Gwadabawa	15	12	0
Kware	9	11	2
Sokoto	40	52	12
Bodinga	12	4	0
Yabo	8	2	0
Dogondaji	5	2	1
Gummi	7	3	0
Zuru	36	15	0
Mahuta	8	2	0
Shanga	14	6	1
Yauri	35	25	2
Warra	11	11	0
Auna	3	2	0
New Bussa	15	9	1
Total	**268 (60.50%)**	**163 (35.35%)**	**19 (4.11%)**

Source: Fieldwork, January 2011

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Table 7.26: The Results of the Analysis of Variance on Literacy Level

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	24.333	20	1.217	5.153	0.000
Within Groups	5.667	24	0.236		
Total	30.000	44			

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7.8 Perception of the causes of tuberculosis

Understanding of the lay person on the causes of a disease has important implications for the utilization of healthcare services and health-seeking behaviour of the individual. There could be a considerable disparity between the lay and professional biomedical explanations of the cause of a disease. Perceived causes help to explain the meanings of a health problem and the implications based on cultural, familial, and personal background. Misconception about the correct cause of a disease could affect patient's attitude towards health-seeking and preventive behaviour. Such beliefs may cause delays in seeking early care and non-adherence to medication. This section therefore, looks at the belief system of the respondents as it affects the prevalence of tuberculosis. The data were obtained from responses of respondents on what they believe causes tuberculosis. Data on this variable are presented in Table 7.27.

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Table 7.27: Respondents' Belief on the Causes of Tuberculosis

Health Facility	Causes of Tuberculosis									
	Dust	God Ordained	Spiritual	Heredity	Cold weather +cold water	Diet	Infection	Unpas. Milk	Smoking	Don't Know
Illela	0	8	5	2	5	0	8	2	2	0
Gwadabawa	0	4	0	0	2	0	4	0	4	12
Kware	0	0	4	0	0	0	13	0	2	3
Sokoto	17	23	3	8	18	2	27	1	27	8
Bodinga	3	1	0	0	3	1	1	1	1	5
Yabo	2	2	0	0	1	0	5	0	0	0
Dogondaji	0	0	0	0	1	0	6	0	1	0
Gummi	1	0	0	0	0	0	4	0	0	5
Zuru	11	2	0	0	7	0	30	0	0	1
Mahuta	3	1	0	0	1	0	4	0	0	2
Shanga	2	0	0	0	1	1	13	2	1	1
Yauri	18	0	0	0	7	0	21	1	17	8
Warra	6	0	0	0	0	0	9	0	1	2
Auna	2	0	1	0	0	0	3	0	0	0
New Bussa	0	7	0	0	0	0	14	0	0	4
Total	**65**	**48**	**13**	**10**	**46**	**4**	**162**	**7**	**56**	**51**
	(14.09%	**(10.41%)**	**(2.81%)**	**(2.16%)**	**(9.97%)**	**(0.98%)**	**(35.14%)**	**(1.51%)**	**(12.14%)**	**(11.06%)**

Source: Fieldwork, January 2011

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Table 7.27 shows that 11.06% of the respondents do not know the causes of tuberculosis. This lack of knowledge, which might be associated with low literacy levels, particularly when associated with lack of employment, could contribute to delays in seeking healthcare and hence the progression of the disease. Among the perceived causes, 14.09% of the respondents attribute it to dust, 10.41% to the wish of God, 2.81% to spirits, 2.16% to heredity, 9.97% to cold weather or cold water, 0.86% to the nature of diet, 35.14% to microbial infection, 1.51% to consumption of unpasteurized milk and 12.14% to smoking. This result is at variance with the ones obtained by Karim *et al* (2011) and Legesse *et al* (2010) that 45.9% of their respondents attributed the cause of tuberculosis to cold air, 38.0% to shortage of food, 21.8% to dusts and 16.4% to smoking. The diverse beliefs could however still serve as an indicator of the ways tuberculosis is understood and treated through different belief systems, in terms of the health seeking behaviour of the patient. The issues of consumption of unpasteurized milk and smoking have been discussed in the earlier sections as lifestyle habits of the respondents, and they are reported here as part of perception of the respondents. The two variables reported here may not necessarily tally with the ones earlier reported. Even though they represent same attributes, they do signify different perspectives.

Interestingly from the table, a larger number (35.14%) of the respondents believe in microbial infection as the cause of tuberculosis. The fact that there are other beliefs about the cause of the disease points to the different ways the disease could be treated, in terms of alternative therapies and delays in seeking healthcare, which according to Oluwadare and Bosede (2010) are a function of level of education, followed by gender and age.

An examination of the role of this variable on the prevalence of tuberculosis was carried out using the Multiple Regression Analyses given by the formula: Y =. $a_0+X_1a_1+X_2a_2+X_3a_3+X_4a_4+X_5a_5+ X_6a_6+ X_7a_7 + X_8a_8+ X_9a_9 + X_{10}a_{10}$, where Y is the prevalence, a_0 is a constant, X_1 represents dust, X_2 is God-ordained, X_3 id Spirit, X_4 is heredity, X_5 is cold weather/climate, X_6 is diet, X_7 is infection, X_8 is consumption of unpasteurized milk, X_9 is cigarette smoking and X_{10} is lack of knowledge of the cause (Table 7.28).

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Table 7.28: The Results of the Regression Analysis on Perceived Causes of TB

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-0.769	1.713		-0.449	0.677
	Dust	3.679	0.365	0.110	10.079	0.001
	God	3.600	0.375	0.229	9.588	0.001
	Spiritual	4.301	1.490	0.026	2.887	0.045
	Heredity	3.598	0.159	0.265	22.638	0.000
	Coldwater	3.966	2.859	0.019	1.387	0.238
	Diet	3.722	0.652	0.147	5.712	0.005
	Infection	4.273	2.435	0.074	1.755	0.154
	Unpastmilk	3.322	0.807	0.046	4.118	0.015
	Smoking	3.383	0.534	0.169	6.334	0.003
	Dontknow	3.522	0.465	0.177	7.571	0.002

a. Dependent Variable: Prevalence

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The results show that the highest positive contribution comes from 'spiritual' cause, followed by 'infection', signifying that they are possible risk factors. This reinforces the role of these variables in affecting the prevalence of tuberculosis in the region as earlier discussed.

Further testing of the significance of this variable on the prevalence using the Analysis of Variance (Table 7.29) showed no statistically significant difference in the means of the variables considered, $F (19, 130) = 0.525$, $p = 0.947$, since the calculated p-value is greater than the alpha value at 0.05 significance level. The finding may not be a surprise since data were based on perceptions. These could vary with the individuals, their levels of literacy and the society they come from, and therefore the data could be subjective. The misconception goes to show why people pay less attention to other factors such as nutrition (and consumption of unpasteurized milk), and the possibility of infection due to contacts. It therefore becomes imperative that the lack of agreement between the biomedical model and socio-cultural beliefs and practices of people need to be properly addressed if tuberculosis is to be controlled. Thus, the finding is in disagreement with the work of Bojja *et al* (2010) and Legesse *et al* (2010) who reported poor diet, heredity and dust among others that could serve as major causes of tuberculosis.

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Table 7.29: The Results of the Analysis of Variance on Perceived Causes of TB

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	569.810	19	29.990	0.525	0.947
Within Groups	7425.023	130	57.116		
Total	7994.833	149			

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7.9 Access to Healthcare

This section examines the factors that affect access to health services for the treatment of tuberculosis. Data on this variable were obtained from the responses of respondents on their ability to access the health centres. These are presented in Table 7.30. The table indicates that generally, travel cost (45.33%) is the major hindrance to access to health services, followed by others (18.87%) and then the attitude of health personnel (13.44%). Travel time (13.02%) and physical distance (9.76%) do not seem to affect access directly but through travel cost. Poor attitude of health personnel (or bad treatment of patients) was identified in Gwadabawa, Illela and Zuru. This is a common phenomenon in many health centres in this country and could play a significant role in influencing the health-seeking behaviour of patients. In another dimension, patients in Sokoto, Bodinga, Shanga and Auna centres reported none of the above as being factors affecting their access to health centres. It is possible that some other social factors, such as perception and belief, and the purdah system are responsible.

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Table 7.30: Responses on Access to Healthcare Services

Health Facility	Travel Time	Physical Distance	Travel Cost	Attitude of Health Personnel	None of the above
Illela	0	1	12	19	0
Gwadabawa	1	3	15	7	0
Kware	0	3	17	0	2
Sokoto	30	0	33	21	50
Bodinga	0	2	4	0	10
Yabo	0	1	6	2	1
Dogondaji	0	3	5	0	0
Gummi	0	2	7	1	0
Zuru	1	12	28	3	7
Mahuta	0	5	5	0	1
Shanga	0	6	14	1	0
Yauri	0	18	35	8	11
Warra	0	4	13	0	1
Auna	0	1	2	0	2
New Bussa	2	3	15	2	3
Total	**31(13.02%)**	**64(9.76%)**	**209(45.33%)**	**62 (13.44%)**	**87(18.87%)**

Source: Field Work, January 2011

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An examination of the relationship of these variables with the prevalence of tuberculosis was carried out using the Multiple Regression Analysis with the regression model as: Y =. $a_0+X_1a_1+X_2a_2+X_3a_3+X_4a_4+X_5a_5$, where Y is the prevalence, a_0 is a constant, X_1 represents time of travel, X_2 represents physical distance, X_3 represents cost of travel, X_4 represents attitude of health personnel and X_5 is for other factors. This model (Table 7.31) showed an almost equal contribution of all the variables. They all have positive contributions to the model, indicating a direct link with the prevalence of tuberculosis. To test the significance of these relationships however, the analysis of variance (ANOVA) was carried out.

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Table 7.31: The Results of the Regression Analysis on Access to Healthcare Services

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	0.021	0.643		0.033	0.974
	Time	3.640	0.249	0.231	14.612	0.000
	Distance	3.786	0.203	0.149	18.640	0.000
	Cost	3.469	0.098	0.299	35.443	0.000
	Heathpers	3.647	0.079	0.206	46.027	0.000
	Others	3.672	0.127	0.386	29.029	0.000

a. Dependent Variable: Prevalence

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The results of the ANOVA (Table 7.32) show no statistically significant difference in the means of the variables considered, $F (23, 51) = 0.503$, $p = 0.963$, since the calculated p-value is greater than the alpha value at 0.05 significance level. Again the significantly lower *Between Group Variation* than the *Within Group Variation* is a testimony for the lack of significant difference. The finding refutes our hypothesis that access to health care as one of the socio-economic correlates, is a determinant of the prevalence of tuberculosis in the study area. Considering the poverty level of the people in the study area (being one of the highest in the country), one would have expected the role of travel cost in determining access to health care in this region. However, the lack of a statistical significance negates this assertion.

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Table 7.32: The Results of the Analysis of Variance on Access to Healthcare Services

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	27.730	23	1.206	0.503	0.963
Within Groups	122.270	51	2.397		
Total	150.000	74			

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7.10 Conclusion

From the foregone, we could see that stations with the highest prevalence (such as Illela, Sokoto and Yauri) also have higher risks of 'ever been infected' and 'health dissatisfaction' among the environmental risk factors. Similarly, places with lower prevalence also have lower risks, except for Auna. Results of the regression analysis show that 'ever been diagnosed of lung and heart-related diseases' seems to have the highest contribution in the model (B=4.943), followed by 'ever ever stayed with a TB patient' (B=2.213) and then 'family member ever been infected with TB' (B=1.411). However, the ANOVA indicated no statistically significant difference in the means of the variables considered.

Among the behavioural risk factors, the regression model showed that sleeping with animals has the highest contribution in the prevalence of tuberculosis, followed by ever being a cigarette smoker and then having ever visited a health centre to treat a disease. Consumption of unpasteurized milk seems to have a negative contribution to TB prevalence. The ANOVA indicated no statistically significant difference in the means of the variables considered. It is apparent therefore that the roles of the perceived environmental and behavioural factors in the prevalence of tuberculosis vary among stations and there might be some sort of synergy among the factors as their respective roles were not pronounced in some stations.

Among the socio-demographic factors, ethnicity did not show any statistically significance but marital status did. Similarly, having 'ever worked', 'type of work', 'and nature of work 'and 'duration of work' showed a statistically significant difference in the means of their variables. Conversely, 'type of ooccupation' showed no statistically significance although the regression model shows farming activity with the highest contribution (4.023) to the prevalence followed by other activities and then business. Also, income level indicated a statistically significant difference among the variables considered in the ANOVA although the regression shows that income level 1,000-50,000 has the highest contribution. Literacy level showed statistical significance whilst perception of the causes of tuberculosis showed no statistically significance. Finally, access to healthcare showed no statistically

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significance in the ANOVA although the regression model showed an almost equal contribution of all the variables.

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By and large, the fact that some of the factors indicated high contribution but no statistical significance can be attributed to the confounding effects of variables such as population, gender or age as characteristics of the respondents. It may also be that some other socio-economic factors not investigated such as living conditions and degree of drug resistance, play a prominent role than the investigated risk factors. A single variable may therefore be inadequate in explaining tuberculosis prevalence at any point in time in any society. Therefore, this chapter attempted to elucidate the roles of these correlates in an effort to ginger up more detailed studies into the roles and interactions of these factors. This is particularly so since an understanding of the causes of tuberculosis and its transmission goes beyond the traditional biomedical model that focuses on the disease agent alone, but requires more understanding of socio-economic characteristics of the people, as well as their culture and belief system. This will go a long way in fostering better understanding of the disease and better control measures. Test findings from all the work history variables; confirm our hypothesis that says "socio-economic correlates such as work history, occupation, income, literacy level, access to health care and perception, affect the prevalence of TB in the region". However, the need for more investigation on the intricate relationships of the work status variables becomes paramount.

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CHAPTER EIGHT

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The study explored seasonal migration of the Fulani and their livestock in relation to the prevalence of pulmonary tuberculosis in the Northwest Region of Nigeria. The study also sought to know whether environmental, behavioural and socio-demographic factors play any role in the prevalence of tuberculosis in the region. The general theoretical literature on zoonotic infection and prevalence of pulmonary tuberculosis, particularly on consumption of unpasteurized milk and its by-products is rather inconclusive. The study therefore sought to answer two of the questions that pertain to this subject:

- ✓ Do the nomadic Fulani and their animals in any way serve as carriers and help in the spread of tuberculosis during the course of seasonal movements within the region?
- ✓ Does the availability of unpasteurized milk or its by-products at the stop-over and destination places have any effect on the prevalence of tuberculosis in the Region?

In this chapter, we shall present highlights of the empirical findings after the introduction. This will be followed by the theoretical/conceptual implications, policy recommendations, areas of future research and conclusion.

8.1 Summary of empirical findings

Fifteen settlements with Directly Observed Therapy Short (DOTS) course centres, identified along the route of Fulani seasonal migration, provided the sampling points where questionnaires were administered. A comparable number of DOTS centres away from the route of migration were also sampled to serve as control. Tuberculosis case registers in these centres in 2010 formed the sampling frame from which the sample of TB patients was drawn. In administering the questionnaire, accidental/purposive/random sampling was employed on all patients currently receiving treatment on TB in the centres. The purpose of the sampling was dependant on the patient presenting himself/herself at the DOTS centre for medication. The sample (461) was apportioned to different DOTS centres proportionately in

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accordance with the prevalence records of each centre during the study period. The questionnaire was designed to collect information on the demographic and socio-economic characteristics of patients, including the cultural and environmental variables that promote tuberculosis infection. Secondary data on population size and geographical coordinates of settlements were also collected. Regression and correlation analyses were carried out to examine the relationships between the variables while the Analysis of Variance and the Test of Mean Difference (Student's t-test) were conducted to test the statistical significance of some relationships.

The main empirical findings are chapter-specific: Chapter Five looked at the spatio-temporal patterns of tuberculosis prevalence; Chapter Six focused on the factors affecting the prevalence; and Chapter Seven looked at the effects of environmental, behavioural and socio-economic/demographic factors on the prevalence. The three chapters were intended to answer the research questions and address the research objectives. Thus far, the study has identified the Fulani seasonal migration routes, the pattern of migration, as well as the origin, stop-over and destination settlements of such movements. In particular, it has looked at the relationships between Fulani seasonal migration and tuberculosis prevalence. This was based on the premise that there could be zoonoses in the infection of tuberculosis between humans and livestock, which has been attested to by many studies. Similarly, it was assumed that zoonoses could occur due to consumption of unpasteurized milk and its by-products. It is then possible that the Fulani could act as carriers of tuberculosis as they move seasonally between the northern and southern parts of the region, and their presence in a particular environment could affect the availability of unpasteurized milk and its product that could promote zoonoses.

The study also determined the spatio-temporal patterns of tuberculosis prevalence in the study area which showed both temporal and spatial variations in the prevalence among both sample and control DOTS centres. The records show that for the sample DOTS centres, monthly variations are even more pronounced for the months of August and December. In fact, December has the highest prevalence and August has the lowest prevalence in those places. Places in the far north (excepting Auna) record their highest prevalence during the months of September to December. There was however no statistically significant difference between the months in the prevalence.

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As for the seasons, there was a statistically significant difference between the dry and the wet seasons in the prevalence of TB

As for the control DOTS centres, highest prevalence was recorded in January and March and the least was in May. There was however a general downward trend from January to December. There was also a statistically significant difference between the months and the seasons in the prevalence.

When comparing the sample and control DOTS centres, it was found that the highest prevalence records were in February and October for the sample stations, while March, January and February were the highest for the control stations but they have similar records for the month of July. Thus, there was an upward trend for sample stations and a downward trend for the control stations but both stations recorded their highest prevalence during the dry season and the lowest during the wet season.

Spatial variations also reflected population size of settlements for both the sample and control stations. The spatial pattern of sample stations shows a slight downward trend as one moves from the north (origins) towards the south (destinations), indicating a distance decay pattern. As for the controls, lowest prevalence was recorded among stations farthest from the route of migration. In all cases, DOTS centres had dominance over all other settlements in the reported prevalence.

The findings have also shown that increase in distance along the route between sample centres portrayed a decrease in the prevalence of tuberculosis, but distance from the route in the case of control centres, does not have any effect on the prevalence. Distance also showed an inverse relationship with prevalence when the patients' home settlements were considered, except for Dogondaji (r= -0.659; p=0.027) and Gwadabawa (r= -0.351; p=0.045). In both sample and control DOTS centres, population size was a determinant, i.e. the higher the population size of a settlement, the higher the recorded prevalence of TB. This could be implicated by the presence of the facility in those settlements or population size may be acting as a confounder.

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Duration of stay of the Fulani in a settlement did not have any effect on the prevalence, but the number of available health facilities had a positive effect on the prevalence, perhaps because the greater the number of facilities in a settlement, the more likely patients are to present themselves at such centres. Similarly, age groups 21-30, 31-40 and 41-50 had the highest prevalence while age groups greater than 60 were the least affected but there was no statistically significant difference between age groups, F (38,51) = 0.723; p = 0.850. As for gender, there was a statistically significant difference (t =16.155; p = 0.000) between males and females.

Concerning the environmental and behavioural factors, the study found no statistically significant difference between the identified factors in the prevalence, (F=19.70) = 1.245, p=0.249 and F (15,44) =1.397, p=0.191 respectively. There were also no statistically significant differences between the rest of the factors on occupations [F (20, 39) = 1.480. p = 0.145], perception [F (19, 130) = 0.525, p = 0.947] and access to health facilities [F (23,51) = 0.503, p = 0.963]. However, there were statistically significant differences between marital status (t =16.155, p = 0.000); ethnicity [F (21,23) = 1.492, p = 0.175]; work status (t = 16.55; p = 0.000); nature of work (t = 16.55; p = 0.000); type of work (t = 16.55, p = 0.000), duration of work period [F(11,48) = 2.772, p = 0.007]; income levels [F(17,57) = 5.407; p = 0.000]; and literacy levels[F (20,24) = 5.152, p = 0.000]. This study therefore examined the factors at play in affecting the prevalence of tuberculosis in the region in an effort to foster better understanding of the disease for more effective surveillance and control measures.

8.2 Theoretical/conceptual implications of the study

The distance decay model (Rotheringham *et al* 1981) stipulates that increase in distance brings about a decrease in interactions among humans and consequently a decrease in contacts (and infection of diseases such as tuberculosis in our case). It is however noted from this study that such rule of thumb does not always follow when considering disease transmission, particularly that of tuberculosis. A number of factors come into play that could hinder the general principle of decrease with distance. This study has however shown that the distance decay model cannot be used

UNIVERSITY OF IBADAN

to make generalizations on all natural activities and processes. There are exceptions due to peculiarities of certain processes, such as disease transmission.

Considering the multitude of factors involved in the prevalence of tuberculosis, this study agrees with the works of many authors in diverse respects and disagrees with many also in diverse respects. In the first instance, it is partly in consonance with the distance decay model on the prevalence of tuberculosis along the route of Fulani migration. On the role of population size, the study concurs with Albert *et al* (2000) and Wallace *et al* (1999) that population size could be a determinant of the prevalence. On the role of age, it agrees with the works of Carbonara *et al* (2005), Gupta *et al* (2011), Tourey *et al* (2010), Rafiza *et al* (2011), Ekrakene and Igelele (2010) and Lienhardt *et al* (2003 that the middle-age group are the most affected, and disagrees with the works of Kirk (2003), Ofukwu (2006), Davies (2006) and HPA (2009) that reported other age groups.

On the role of gender, the study is in agreement with Itah and Udofia (2005), Liao *et al* (2012), Lienhardt *et al* (2003 and 2005), Mohammed *et al* (2011), Yim *et al* (2010) and Singh *et al* (2007) who reported more males being prone to tuberculosis infection than the females. On contacts with the index case, the study agrees with Singh *et al* (2005), Hill *et al* (2006), Kehinde *et al* (2011), Daborn (1996), Lienhardt *et al* (2003); Tornce *et al* (2004), Nakaoka *et al* (2006) and Sororg *et al* (2011) all of which reported contacts with index case as being one of the environmental risk factors in the infection and prevalence of tuberculosis.

On the issue of contacts with animals, the study is in agreement with the works of Lonnroth *et al* (2009), Yim *et al* (2010), Erahl *et al* (2009) and Dye *et al* (2009) who maintained that tuberculosis infection is as a result of a complex interaction between the social and physical environment as well as the characteristics of the disease agent. The study however is in disagreement with Ayele *et al* (2004), Shitaye *et al* (2007), Darborn *et al* (1996), Alhaji *et al* (1997), Cosvi *et al* (1998), Cadmus *et al* (2006), Thoen *et al* (2006), Yumi *et al* (2007), Ofukwu *et al* (2008), Beals (2007) and Abubakar *et al* (2011) who reported contacts with animals as being a risk factor in the infection and prevalence of tuberculosis. On consumption of unpasteurized milk and its by-products, the study concurs with Lonnroth *et al* (2009), Yim *et al* (2010), Erahl

UNIVERSITY OF IBADAN

et al (2009) and Dye *et al* (2009) who exonerated this factor as a risk, and disagrees with the works of Ayele *et al* (2004), Thoen *et al* (2006), Abubakar et al (2010), Sharubutu (2007), Chigbu *et al* (2010), Lam *et al* (2004), Arcavia (2004), Ariyothai *et al* (2004), Singh *et al* (2005, Lin et *al* (2009) and Ekrakene *et al* (2010) who attributed this factor as a risk in the prevalence of tuberculosis.

The study agrees with Hill *et al* (2006) and Gesler (2002) that ethnicity plays a role in the prevalence of tuberculosis and with Rafiza *et al* (2011) that being married could be a risk factor in the prevalence of tuberculosis. It also agrees with Ogboi *et al* (2010), Oboku *et al* (2012) and Gatrel (2006) that never had a job could be a risk factor; Itah and Udofia (2005) that paid job could be a risk factor; Syme *et al* (1996), Ogboi *et al* (2010), Gupta *et al* (2011) and Hill *et al* (2006) that being unskilled could contribute to the prevalence; Rafiza *et al* (2011) and Kehinde *et al* (2011) that longer work period could mean longer exposure to the disease; Ogboi *et al* (2010), Syme *et al* (1976), Lienhardt *et al* (2005), Hill *et al* (2006), Gustafron *et al* (2004), Nwacholor and Thomas (2000) and Shetty *et al* (2006) for attributing high tuberculosis prevalence to poor income; and Oboku *et al* (2012), Lienhardt *et al* (2009) for reporting low literacy level as being a risk factor. Conversely the study disagrees with the works of Gupta *et al* (2011) that work history does not matter in the prevalence of tuberculosis; Itah and Udofia (2005) that the type of work done does not matter; Itah and Udofia (2005) that traders are more prone to infection than other occupational groups; Tornce *et al* (2004) who reported that income level does not affect prevalence; Karim *et al* (2011) and Legesse *et al* (2010) who reported cold air as a perceived risk factor; and Bojja *et al* (2010) and Legesse *et al* (2010) who reported poor diet, heredity and dust as some of the perceived factors that affect the prevalence of tuberculosis. Therefore, causes of tuberculosis and its' risk factors cannot be generalized as they are society-specific.

This study affirms the belief on the complex nature of factors of disease prevalence, most especially tuberculosis, which is regarded as a disease of the poor. The implication of this is that a clear understanding of how tuberculosis is contracted and transmitted is a pre-requisite to understanding variations in its prevalence. Factors responsible for infection may not necessarily be responsible for transmission as well. The characteristics of the tubercule may determine the presence of the disease for

UNIVERSITY OF IBADAN

infection but actual infection may be dependent on environmental risk factors and socio-economic and cultural factors. Similarly, the way these factors affect infection may be different from the way they affect transmission. A clear understanding of each of these factors and their interactions requires an understanding of the way they combine to affect prevalence. In other words, the dynamics of these factors determine the prevalence, and these dynamics cannot be understood unless all the factors are considered holistically. This is particularly so because:

a) it is not all types of unpasteurized milk that can be said to have the pathogens – only those that come from infected cows;
b) We need to ascertain the level of infection among cows, combined with lifestyle factors, to substantiate our claims; and we need to clinically ascertain the type of TB. As long as we cannot differentiate between the two, it will be difficult to attribute prevalence of TB to certain areas. Clear cut clinical tests need to support perception on the causes.

The important contribution of the study to knowledge is that of relations between Fulani seasonal migration as lifestyle course and tuberculosis prevalence. The study has been able to dispel the misconception that all types of unpasteurized milk and its by-by-products can cause TB. Even if it does, the attribution is very minimal, just like any other infectious agent. This type of study had not been done earlier on the Fulani and therefore adds to knowledge on the role of lifestyle in disease transmission. More importantly, the study refutes the work of clinicians on the role of unpasteurized milk and its by-products, from the socio-economic point of view, in causing tuberculosis.

8.3 Policy implications and recommendations

One particular policy programme intended to curve tuberculosis menace in Nigeria is the establishment of tuberculosis DOTS centres in all the Local Government Areas of the country that will provide free medication to tuberculosis patients. This has made some progress but evidence from several studies, including those of Abubakar *et al* (2011), Chigbu *et al* (2010), Ekrakene et al (2010), Kehinde *et al* (2011), Ogboi *et al* (2010), Oluwadare and Bosede (2010) and this thesis seem to point to the fact that the level of public awareness of this service is still low, perhaps due to literacy level. This study has used empirical findings to show the roles of many factors that may hinder

UNIVERSITY OF IBADAN

the success of this programme. The arguments suggest the need for a more holistic approach to TB control, rather than simple treatment of the disease. In the light of these implications, it is recommended that:

- First and foremost, health facilities should be well-equipped to enable them clinically distinguish between the two forms of tuberculosis caused by bovine and mycobacterium tubercules with a view to ascertaining the proper control measures to adopt.
- The fact that treatment of the disease is provided free to patients does not preclude the risk posed to those not yet infected. Therefore, efforts should be geared towards educating the public on the possible ways of getting infected and in avoiding them so as to minimize the risk to others. So also, efforts should be made at reducing contacts between the index patients and the non-infected so as to reduce the risk of infection and transmission.
- For the fact that the factors at play in the prevalence of tuberculosis in the study area are intricate, understanding of all the risk factors and correlates would enable government take appropriate measures in surveillance and control. This requires more detailed studies and surveys on specific risk factors and correlates of the disease.
- As this region is blessed with a high population of livestock that are in constant seasonal movement across the region, and bearing in mind the possible danger of infection due to contacts with infected animals, it becomes necessary for government to continuously carry out tuberculosis surveillance within the region.

8.4 Areas of further research

Going by the findings that implicated several factors in the prevalence of tuberculosis in the region, as well as their intricate relationships, there is need to carry out further research in other places so as verify, substantiate, affirm or nullify the roles of some of these factors. This should improve our understanding of the transmission and prevalence of tuberculosis in the region and elsewhere for better surveillance and control. This is particularly so if we are to find answers to questions yet unanswered such as: To what extent could the Fulani and their livestock pose as carriers to

UNIVERSITY OF IBADAN

tuberculosis infection? What is the level of interaction among the risk factors and socio-economic correlates in affecting tuberculosis prevalence? In the light of this, it is recommended thus for future research:

- In view of the perception of people in the study area concerning the causes of tuberculosis, it becomes imperative for government and the academia to carry out more detailed studies on the social life of the people within the region, with a view to understanding the socio-economic factors of tuberculosis infection and transmission better.

- In spite of the fact that the study has not implicated consumption of unpasteurized milk and its by-products in affecting the prevalence of tuberculosis in the region, there is still the need to carry out research on the people who actually consume unpasteurized milk and its by-products so as to ascertain exactly whether or not these by-products cause tuberculosis. Simple laboratory determination without a social survey will not substantiate the attribution of unpasteurized milk to tuberculosis, even as prescribed by the biomedical model since individuals and societies differ in their lifestyles.
- There is the need to carry out empirical studies on zoonotic infection of tuberculosis. Those societies that have been taking unpasteurized milk or its by-products as their staple for ages will never accept the fact that these by-products pose a risk to their health unless it is proven beyond reasonable doubt.

- Finally, the interplay of factors responsible for the exposure, infection and spread of tuberculosis requires more multidisciplinary researches on tuberculosis prevalence in Nigeria so as to understand its nature. Disparate researches by biomedical professionals and epidemiologist negate the roles of socio-economic/cultural factors and thus the role of the social scientist. Therefore, the biomedical model must be integrated with the social science model within a single framework for proper understanding of the dynamics of tuberculosis.

UNIVERSITY OF IBADAN

8.5 Conclusion

From the findings of the study, it is obvious that the Fulani do not seem to serve as carriers of tuberculosis in the region. This is because the availability of unpasteurized milk or its by-products in the stop-over or destination places does not affect the prevalence of tuberculosis in those areas. The fact that consumption of unpasteurized milk is perceived to be relevant as one of the causes of tuberculosis among the behavioural factors is rather subjective and needs to be substantiated by concrete empirical evidences. Environmental risk factors, particularly history of infection such as contacts with index patients, play significant roles in the prevalence of the disease in the study area. Similarly, the month of the year or the season plays a significant role in the prevalence, as well as ethnicity of patient which in any case relates to cultural practices. Furthermore, having a paid job reduces the risk of infection by increasing the capability of the individual to pay for treatment and maintain a good diet, thus reducing susceptibility to the disease. In other words, higher income reduces the risk of infection to the disease. Finally, population size of settlements is also a determinant of the prevalence of TB in the study area but climate may be playing a role the TB prevalence.

UNIVERSITY OF IBADAN

REFERENCES

Abubakar, A. A., Brooks, P.H., Abdullahi, S.U., Kudi, A.C. and Okaiyeto, O. 2005. Epidemiology of bovine and human tuberculosis in the Federal Capital Territory of Nigeria, Abuja. *Proceedings of the British Society of Animal Science Annual Conference*. 4th-6th April. York, UK.

Abubakar, U. B., Ameh, J. I., Abdulkadir, I. A., Salisu, I., Okaiyeto, S. O. and Kudu, A. C. 2011, Bovine Tuberculosis in Nigeria: A review, *Veterinary research.* 14 (1): 24-27.

Akinbowale, O. J. 2008. *Identification and Genotyping of Mycobacterium Tuberculosis Complex infection of the human/domestic animals/wildlife interface in Nigeria and South Africa,* A Dissertation for the award of the degree of MAGISTER SCIENTIAE in the Department of Veterinary Tropical Diseases, Faculty of Veterinary Sciences, University of Pretoria, South Africa: 1-83. Retrieved 9th September 2011 from http://upetd.up.ac.za/thesis/submitted/etd-05132009-165911/unrestricted/dissertation.pdf

Albert, D., P., Gesler, W. M. and B. Levergood (eds**).** 2000. *Spatial Analysis, GIS, and Remote Sensing Applications in the Health Sciences*, Ann Arbor Press, Chelsea, Michigan: 1-217.

Alhaji, I. and Schnurrenberger, P. 1977. Public health significance of bovine tuberculosis in four Northern States of Nigeria. a mycobacteriological study. *Nigerian Medical Journal.* 7(4):384–386.

Araoye, M. O. 2004. *Research Methodology with Statistics for Health and Social Sciences.* Ilorin*:* Nathadex Publishers.

Arcavia, L. and Benowitz, N. L. 2004. Cigarette smoking and infection, *Achieve of International Medicine.* 164:2206-2216.

Ariyothai, N., Podhipak, A., Akarasewi, P., Tornee, S., Smithtikarn, S. and Thongprathum, P. 2004. Cigarette smoking and its relation to pulmonary tuberculosis in adults. *Southeast Asian Journal of Tropical Medicine and Public Health.* 35(1):n219-227.

Ayele, W. Y., Neill, S. D., Zinsstag, J., Weiss, M. G. and Pavlik, I. 2004. Bovine tuberculosis: an old disease but a new threat to Africa. *International Journal of Tuberculosis and Lung Diseases.* 8(8): 924–937.

UNIVERSITY OF IBADAN

Association for the Development of Education in Africa (ADEA). 2005. *African Experiences Country Case Studies: Improving the Quality of Nomadic Education in Nigeria.* A study conducted by the Federal Ministry of Education Nigeria for ADEA. Paris. Retrieved 6th January 2011 from http://adeanet.org/downloadcenter/publications/03_ Nigeria_eng_web.pdf.

Babatola, O. 2006. *International Population Mobility and the Risk of Sexual Health among Business Operatives in Lagos, Nigeria*, an unpublished M. Phil (Geography and Planning) Thesis, University of Lagos.

Beals, F.T. 2007. The Risk of Bovine Tuberculosis from Raw Milk Consumption with A Focus On Michigan in Wise Traditions in Food, Farming and the Healing Arts. *The quarterly magazine of the Weston A. Price Foundation*. Retrieved 7th February 2012 from http://www.westonaprice.org/farm-a-ranch/risk-of-bovine-tb-from-raw-milk-consumption.

Beggs, C.B., Noakes, C.J., Sleigh, P.A., Fletcher, L. A. and Siddiqi, K., 2003. The transmission of tuberculosis in confined spaces: An analytical review of alternative epidemiological models. *International Journal of Tuberculosis and Lung Diseases*, 7:1015-26.

Blench, R. 1999. *Traditional Livestock Breeds: Geographical Distribution and Dynamics in Relation to the Ecology of West Africa*. Overseas Development Institute. London, UK.

Boccia, D., Hargreaves, J., De Stavola, B. L., Fielding, K., AbSchaap, A., Godfrey-Faussett, P. and Ayles, H. 2011. The association between household socioeconomic position and prevalent tuberculosis in Zambia: a case-control study. *PLoS ONE.* 6(6): e20824. doi:10.1371/journal.pone.0020824.

Bojja Venkatraju, B and Prasad, S. 2010. Beliefs of patients about the causes of Tuberculosis in rural Andhra Pradesh, *International Journal of Nursing and Midwifery*. 2 (2): 21-27. Retrieved 8th June 2011 from http://www.academicjournals.org/ijnm

Cadmus, S., Palmer, S., Okker, M., Dale, J., Gover, K., South, N., Jahans, K., Hewinson, R. G. and Gordan, S. V. 2006. Molecular analysis of human and bovine tubercule bacilli from local setting in Nigeria. *Journal of Clinical Microbiology*. 44: 29-34.

UNIVERSITY OF IBADAN

Carballo, M. 2007a. The challenge of migration and health. *International Centre for Migration and Health.* Geneva.

Carbonara, S., Babudieri, S, Longo, B., Starnini, G., Monarca, R., Brunetti, B., Andreoni, M., Pastore, G. , De Marco, V., , G. Rezza, G. and GLIP (Gruppo di Lavoro Infettivologi Penitenziari). 2005. Correlates of Mycobacterium tuberculosis infection in a prison population. *European Respiratory Journal*. 25: 1070–1076.

Center for Disease Control (CDC). 2008. Federal air travel restrictions for public health purposes --- United States, June 2007--May 2008. 57(37):1009-1012. Retrieved 29th October 2013 from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5737a1.htm,

Cetron, M., Jay Keystone, J., David Shlim, D. and Steffen, R. 1998. Traveller's health. *Emerging Infectious Diseases (Special Edition)*. 4 (3): Retrieved 18th September 2010 from http://wwwnc.cdc.gov/eid/article/4/3/98-0315_article.htm ,

Chabasse, D., Roure, C. and Rhaly, A. 1985. The health of nomads and semi-nomads of the Malian Gourma: an epidemiological approach. *Population, Health and Nutrition in the Sahil.* A.G. Hill. ed. London: Routledge and Kegan Paul: 319–339.

Chigbu, L. N. and Iroegbu, C. U. 2010. Incidence and spread of *Mycobacterium tuberculosis*-associated infection among Aba Federal Prison inmates in Nigeria. *Journal of Health, Population and Nutrition.* 28(4): 327–332.

Clark, M., Riben, P. and Nowgesic, E. 2002, The association of housing density, isolation and tuberculosis in Canadian First Nations communities. *International Journal of Epidemiology*, 31:940-43.

Daborn, C.J., Grange, J.M., Kazwala, R.R. 1996.The bovine tuberculosis cycle – an African perspective. *Social and Applied Bacteriological Symposium*., 25, 27-32.

Davies, P. D. O. 2006. Tuberculosis in humans and animals: are we a threat to each other? *Journal of Royal Society of Medicine.* 99(10): 539-540

Dye, C., Lönnroth, K., Jaramillo, E., Williams, B. G. and Raviglione, M. 2009. Trends in tuberculosis incidence and their determinants in 134 countries, *Bulletin of World Health Organization.* 87:683–691.

UNIVERSITY OF IBADAN

Ekrakene, T and Igeleke, C. L. 2010. Prevalence of pulmonary tuberculosis among active and passive smokers of cigarette in Benin City, Nigeria. *International Journal of Biomedical and Health Sciences.* 6 (1): Also available at http://www.asopah.org.

Erah, P. O. and Ojieabu, W. A. 2009. Success of the control of tuberculosis in Nigeria: a review. *International Journal of Health Research.* 2(1): 3-14 (e214p21-32) Available at http://www.ijhr.org

Federal Ministry of Health (Nigeria). 2004. *National Tuberculosis and Leprosy Control Programme Workers Manual*, 4th edition.

Gatrell, A.C. 2006. *Geographies of Health: An Introduction*. Blackwell Publishers, Oxford

Gesler, W. M. and Kearns, R. A. 2002. Culture/place/health. London. Routledge.

Givaudan, M., Pick, S., Teresa, M., de Venguer, T. and U. Xolocotzin . 2002. Bridging the communication gap: provider to patient written communication across language and cultural barriers. 1-27. Retrieved 29th October 2013 from http://hablamosjuntos.org/pdf_files/IMIFAP.PaperI.pdf

Gupta, S., Shenoy, V. P., Mukhopadhyay, C., Bairy, I. and Muralidharan, S. 2011. Role of risk factors and socio-economic status in pulmonary tuberculosis: a search for the root cause in patients in a tertiary care hospital, South India *Tropical Medicine and International Health.* 16 (1): 74–78. doi:10.1111/j.1365-3156.2010.02676.x.

Gustafson, P., Gomes, V.F., Vieira, C.S., Rabna, P., Seng, R., Johansson, P., Sandstrom, A., Norberg, R., Lisse, I., Samb, B,. Aaby, P. and Naucle, A. 2004, Tuberculosis in Bissau: incidence and risk factors in an urban community in sub Saharan Africa. *International Journal of Epidemiology.* 33(1):163-172.

Guwatudde, D., Zalwango, S., Kamya, R., Dabanne, S. M., Diaz, M., Okwera, A. Mugerwa, R. D., King, C., and Whalen, C. C., 2003, Burden of tuberculosis

Hardie, R. M., Wall, P. G., Gott, P., Bardhan, M. and Bartlett, C.L.R. 2007**.** Infectious diarrhoea in tourists staying in a resort hotel. *Emerging Infectious Diseases,* 5 (1) Jan.-March 1999.

Health Protection Agency (HPA). 2009. *Reducing the risk of human M.bovis infection: Information for farmers.* Bovine TB pages.

UNIVERSITY OF IBADAN

Hill, P. C., Jackson-Sillah, D., Donkor1, S. A., Otu1, J., Adegbola, R. A. and Lienhardt, C. 2006. Risk factors for pulmonary tuberculosis: a clinic-based case control study in The Gambia. *BMC Public Health.* 6:156 doi:10.1186/1471-2458-6-156, http://www.biomedcentral.com/1471-2458/6/156.

Hussain, H., Akhtar, S. and Nanan, D. 2003. Prevalence of and risk factors associated with Mycobacterium tuberculosis infection in prisoners. North West Frontier Province, Pakistan. *International Journal of Epidemiology* 32(5):794-799

Idigbe, E. O., Anyiwo, C.E. and. Onwujekwe, I. 1986. Human pulmonary infection with bovine and atypical mycobacteria in Lagos, Nigeria. *Journal of Tropical Medicine and Hygiene.* 89:143–148.

Iseman, M. 1994. Evolution of drug-resistant tuberculosis: A tale of two species. *PNAS.* 91(7): 2428-2429.

Ishola, O. O., Tanimowo, J.A. and Ogundipe, G.A.T. 2001. The prevalence of tuberculosis in slaughtered cattle and humans in Osun State, Nigeria. *African Journal of Biomedical Research.* 4: 69-71.

Itah, A. Y. and Udofia, S. M. 2005. Epidemiology and endemicity of pulmonary tuberculosis (PTB) in South-eastern Nigeria. *Southeast Asia Journal of Tropical Medicine and Public Health.* 36:317-323.

Karim, F., Johansson, E., Diwan, V. K. and Kulane, A.2011. Community perceptions of tuberculosis: A qualitative exploration from a gender perspective. *Public Health.* 125: 84-89.

Kehinde, A. O., Baba, A., Bakare, R. A., Ige, O. M., Gbadeyanka, C. F. and Adebiyi, O.E. 2011. Pulmonary tuberculosis among health care workers at two designated DOTS Centers in urban city of Ibadan, Nigeria. *Indian Journal of Medical Research. 133:* 613-617.

Kirk, J.H. 2003. *Tuberculosis—Human and Cattle*. School of Veterinary Medicine, University of California, Davis, Tulare, CA 93274: 1-3.

Lam, W.K., White, N.W. and Chan-Yeung, M. M. 2004. Lung cancer epidemiology and risk factors in Asia and Africa. *International Journal* of *Tuberculosis and Lung Diseases.* 8:1045-57.

UNIVERSITY OF IBADAN

Legesse, M., Ameni, G., Mamo, G., Medhin, G., Shawel, D., Bjune, G. and Abebe, F. 2010. Knowledge and perception of pulmonary tuberculosis in pastoral communities in the Middle and Lower Awash Valley of Afar region, Ethiopia. *BMC Public Health*. 10:187doi:10.1186/1471-2458-10-187.

Liao, C., Hsieh, N., Huang, T., Cheng, Y., Lin, Y., Chio, C., Chen, S. and Ling, M. 2012. Assessing trends and predictors of tuberculosis in Taiwan, *BMC Public Health*. 12:29. also available at http://www.biomedcentral.com/1471-2458/12/29.

Lienhardt, C. 2001, From exposure to disease: The role of environmental factors in susceptibility to and development of tuberculosis. *Epidemiological Review*, 23:288-301.

___________, Fielding, K., Sillah, J., Tunkara, A., Donkor, S., Manneh, K., Warndorff, D., Keith P. M. and **Bennett,** S. 2003. Risk Factors for Tuberculosis Infection in Sub-Saharan Africa: A contact study in The Gambia. *American Journal of Respiratory and Critical Care Medicine*. 168: 448-455.

____________, Bah, B., Gustafson, P., Warndorff, D., Palayew, M., Lisse, I., Donko,r S., Diallo, S. 2005, Investigation of the risk factors for tuberculosis: a case-control study in three countries in West Africa. *International Journal of* Epidemiology. 34(4): 914-923.

Lien, L.T., Hang, N.T.L., Kobayashi, N., Yanai, H., Toyota, E., Sakurada, S., Thuong, P. H., Cuong, V. C., Nanri, A., Mizoue, T., Matsushita, I., Harada, N., Higuchi, K., Le Anh Tuan, L. N. and Keicho, N. 2009. Prevalence and risk factors for tuberculosis infection among hospital workers in Hanoi, Vietnam. *PLoS ONE*. 4(8): e6798. doi:10.1371/journal.pone.0006798

Lonnroth, K., Jaramill, E., Williams, B. G. and C. Dye, 2009, Raviglione M: Drivers of tuberculosis epidemics: the role of risk factors and social determinants. *Social Science and Medicine*. 68(12):2240- 2246.

Lopez De Fede, A., Stewart, J. E., Harris, M. J. and Mayfield-Smith, K.2008. Tuberculosis in socioeconomically deprived neighbourhoods: missed opportunities for prevention. *International Journal of Tuberculosis and Lung Diseases*. 12(12):1425-1430.

Mackenbach, J. P., Stirbu, I., Roskam, A. J., Schaap, M. M., Menvielle, G., Leinsalu, M. and Kunst, A. E. 2008. Socioeconomic inequalities in health in 22 European countries. *N English Journal of Medicine*. 358(23):2468-2481.

UNIVERSITY OF IBADAN

Mawak, J. D., Gomwalk, N.E., Bello, C.S.S. and Kandakai-Olukemi, Y.T. 2006. Human pulmonary infections with bovine and environment (Atypical) mycobacteria in Jos, Nigeria. *Ghana Medical Journal*. 40(4): 132–136.

McGeary, A. 2008. The Role of Mycobacterium bovis in tuberculosis in Africa. *Medical Journal of Therapeutics Africa.* 2 (1): 59-62.

Meade, M. S. and Erickson, R.S. 2000. *Medical Geography.* Second Edition. The Guilford Press, New York.

Misra, O. P. and D. K. Mishra. 2012. Simultaneous effects of control measures on the transmission dynamics of chikungunya disease. *Applied Mathematics.* 2(4): 124-130.
DOI: 10.5923/j.am.20120204.05. Retrieved 29th October 2013 from http://article.sapub.org/10.5923.j.am.20120204.05.html

Mitsos, L. M., Cardon, L.R., Ryan, L., LarCourse, R.J., North, R.J. and Gros, P. 2003. Susceptibility to tuberculosis: a locus on mouse chromosome 19 (Trl- 4) regulated *Mycobacterium tuberculosis* replication in the lungs. *Proceedings of the National Academy of Science, USA.* 100:6610-6615.

Mohammed, T., Amare, D., Fasil, T., Salihu, A., Luc, D. and Robert, C. 2011. Risk factors of active tuberculosis in people living with HIV/AIDS in Southwest Ethiopia: a case control study. Ethiopian Journal of Health Sciences. 21 (2): 131-139.

Muniyandi, M. and Ramachandran, R. 2008. Socioeconomic inequalities of tuberculosis in India. *Expert Opin Pharmacother.* 9(10):1623-1628.

Nakaoka, H., Lawson, L., Squire, S. B., Coulter, B., Ravn, P., Brock, I., Hart, C. A. and.Cuevas, L. E. 2006. Risk for tuberculosis among children. *Emerging Infectious Diseases.* 12 (9): 1383-1388.

Nakaya, T. 2001. Local spatial interaction modelling based on geographically-weighted regression approach. *Geojournal.* 53: 347-358.

National Bureau of Statistics (NBS). 2012. *Social statistics in Nigeria. Part III: health, employment, public safety and vital registration*: 1-76

National Population Commission (NPC). 1991. *National Population Census of the Federal Republic of Nigeria.*

National Population Commission (NPC). 2006. *National Population and Housing Census of the Federal Republic of Nigeria.*

UNIVERSITY OF IBADAN

Nwacholor, F. N. and Thomas, J. V. 2000. Tuberculosis in Ibadan, Nigeria – a 30 year review. *Central African Journal of Medicine*. 46: 287-292.

Obuku, E. A., Meynell, C. Kiboss-Kyeyune, J., Blankley, S., Atuhairwe, C., Nabankema, E., Lab, M., Jeffrey, N. and Ndungutse, D. 2012. Socio-demographic determinants and prevalence of tuberculosis knowledge in three slum populations of Uganda. *BMC Public Health*. 12:536 doi: 10.1186/1471-2458-12-536.

Ofukwu, R.A., Oboegbulem, S.I. and Akwuobu, C. A. 2008. Zoonotic Mycobacterium species in fresh cow milk and fresh skimmed, unpasteurised market milk (*nono*) in Makurdi, Nigeria: implications for public health. *Journal of Animal and Plant Science*. 1(1): 21-25. Retrieved 2nd July 2010 from http://www.biosciences.elewa.org/JAPS.

Ofukwu, R.A. 2006. *Studies on the epidemiology of bovine and human tuberculosis in Benue State, Nigeria*. A PhD dissertation, Faculty of Veterinary Medicine, University of Nigeria, Nsukka: 15.

Ogboi S. J., Idris S. H., Olayinka A. T. and Junaid, I. 2010. Socio-demographic characteristics of patients presenting pulmonary tuberculosis in a primary health centre, Zaria, Nigeria. *Journal of Medical Laboratory and Diagnosis.* 1(2): 11-14. Retrieved 28th August 2011 from http://www.academicjournals.org/JMLD.

Okafor, S. I. 2008. Location, distribution, and question of justice, an Inaugural Lecture, University of Ibadan. Ibadan University Press, Ibadan.

Oluwadare, C. O. and Bosede, I. 2010. Health seeking behaviour of tuberculosis patients in Ekiti State, Nigeria. *Ethno Medicine.* 4(3): 191-197.

Petter, M. F., Otto, F. S., Shiirev-adiya and Chinbat, B. 1997. Health status and risk factors of Semi-nomadic pastoralists in Mongolia: a geographical approach. *Social Science and Medicine.* 44 (11): 1623-1647.

Public Health Agency of Canada, 2007, Housing conditions that serve as risk factors for tuberculosis infection and disease, *Canada Communicable Disease Report*, 33. ACS-9, 2007, http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/07vol33/acs-09/index-eng.php assessed 20th February, 2014.

UNIVERSITY OF IBADAN

Rafiza, S., Krishna Rampal, K. G. and Tahir, A. 2011. Prevalence and risk factors of latent tuberculosis infection among health care workers in Malaysia. *BMC Infectious Diseases*. 11:19. also available at http://www.biomedcentral.com/1471-2334/11/19.

Rotheringham, A. Stewart. 1981. Spatial structures and distance decay parameters, *Annals of the Association of American Geographers*. 71(3): 425-436

Saunder, K. 2001. Diagnosing tuberculosis in the presence of HIV – a review from a rural hospital. *African Health*. 23: 2-6.

Schelling, E., Diguimbaye, C., Daoud, S. Nicole, J. Boerlin, P., Tanner, M. and Zinsstag, J. 2003, Brucellosis and Q-fever seroprevalences of nomadic pastoralists and their livestock in Chad. *Preventive Veterinary Medicine*. 61: 279–293.

Sharubutu, G. 2007. Source of TB traces to dairy by-products consumption. *Daily Triumph*. FRIDAY APRIL 27.

Shaw, M. 2004, Housing and Public Health. *Annual Review of Public Health*, 25:397-418.

Sheik-Mohamed A. and Velema J.P. 1999. Where health care has no access: the nomadic populations of sub-Saharan Africa. *Tropical Medicine and International Health*. 4: 695-707.

Shetty, N., Shemko, M., Vaz, M. and D'Souza, G. 2006. An epidemiological evaluation of risk factors for tuberculosis in South India: a matched case control study. *International Journal of Tuberculosis and Lung Diseases*. 10(1): 80–86.

Shitaye, J.E., Tsegaye, W. and Pavlik, I. 2007. Bovine tuberculosis infection in animal and human populations in Ethiopia: A review. *Veterinary Medicine*, 52(8): 317-332.

Singh, M., Mynak, M. L., Kumar, L., Mathew, J. L. and Jindal, S. K. 2005. Prevalence and risk factors for transmission of infection among children in household contact with adults having pulmonary tuberculosis, *Achieves of Disease in Childhood*.90:624-628 doi:10.1136/adc.2003.044255.

Smit, M.A. 2005. Transmission of tuberculosis is linked to historical patterns of human migration. *Genome Research*. October 2005

UNIVERSITY OF IBADAN

Smith, D. M. 1982. Geographical perspectives on health and health care. *Contemporary Perspectives in Health and Health Care*, eds. J. Cornwell et al. Occasional Paper (20): 1-27. Department of Geography, Queen Mary College, University of London.

Soborg, B., Andersen, A. B., Melbye, M., Wohlfahrt, J., Andersson, M. Biggar, R, J., Ladefoged, K., Thomsend, V. O. and Kocha, A. 2011. Risk factors for Mycobacterium tuberculosis infection among children in Greenland. *Bulletin of World Health Organization.* 89: 741–748E | doi:10.2471/BLT.10.084152.

Syme. S. L. and Berkman, L. F. 1976. Social class, Susceptibility and Sickness. *Journal of Epidemiology* (*Formerly American Journal of Hygiene*).104 (1): 1-8

Thoen, C., LoBue, P. and De Kantor, I. 2006. The Importance Mycobacterium bovis as a zoonosis. *Veterinary Microbiology*. 112(2-4): 339- 345.

Tornee, S., Kaewkungwal, J., Fungladda, W., Silachamroon, U., Akarasewi, P. and Sunakorn, P. 2004. Risk factors for tuberculosis infection among household contacts in Bangkok, Thailand. *Southeast Asian Journal of Tropical Medicine and Public Health.* 35 (2): 375-383.

Touray, K., Adetifa, I. M., Jallow, A., Rigby, J., Jeffries, D., Cheung, Y. B., Donkor1, S., Adegbola R. A., and Hill, P. C. 2010. Spatial analysis of tuberculosis in an urban West African setting: is there evidence of clustering? *Tropical Medicine and International Health.* 15 (6):664-672.

Udo, R. K. 1970. *Geographical regions of Nigeria.* Heinemann Education Books Ltd. London.

United States Embassy in Nigeria. *January 2012 Economic Section*. Available Retrieved 15th September, 2012 from http://nigeria.usembassy.gov.

Vander Wal, E. Paquet, P. C. and J.A. Andres. 2012. Influence of landscape and social interactions on transmission of disease in a social cervid. *Molecular Ecology*. 21: 1271–1282. doi: 10.1111/j.1365-294X.2011.05431.x. Retrieved 29th October 2013 from usask.ca/~ejv424/Vander Wal et al 2012 MolEco.pdf

UNIVERSITY OF IBADAN

van Cleeff, M.R.A., Becx-Bleumink, M., Bosman, M.J., de Coster, E.M., Tolba, F.M. and Veen, J. eds.. 1995. Tuberculosis control in North and South: four strategies for different socio-economic situations. *Health Matters: Public Health in North–South Perspective.* Royal Tropical Institute, Amsterdam. 217–241.

Wallace, R. **and** Wallace, D. 1997**.** Socioeconomic determinants of health: Community marginalisation and the diffusion of disease and disorder in the United States. *British Medical Journal.* 314:1341.

Wanyeki, I., Olson, S., Brassard, P., Brassard, P., Menzies, D., Ross, N., Behr, M. and Schwartzman, K. 2006, Dwellings, crowding andb tuberculosis in Montreal. *Social Science and Medicine*, 63:501-11

Weitz, R. 2007. *The Sociology of health, illness and health care*. New York, Wadsworth.

World Health Organization. 2006. *Global tuberculosis control-WHO Report.* http://www.ij-healthgeographics.com/sfx_links.asp?ui=1476-072X-5-33&bibl=B7. WHO/HTM/TB/2006.331. Published online (Retrieved February, 2007).

Yim, J. J. and Selvaraj, P.2010, Genetic susceptibility in tuberculosis. *Respirology*. 15(2):241- 256

Yumi, U. and Tooru, M. 2007. Tuberculosis as a zoonosis from a veterinary perspective. *Compendium of Immunological and Infectious Diseases.* 30: 415-425.

UNIVERSITY OF IBADAN

APPENDIX I: THE QUESTIONNAIRE

DEPARTMENT OF GEOGRAPHY
FACULTY OF THE SOCIAL SCIENCES
UNIVERSITY OF IBADAN, IBADAN
"NOMADIC PASTORALISM AND THE PREVALENCE PULMONARY OF TUBERCULOSIS IN THE NORTHWEST REGION, NIGERIA"

LOCALITY:............................ LGA:......................... STATE:......................
INTERVIEWER:.. DATE:................................

1.0 INTRODUCTION

This research is being carried out by Abubakar Garba Fada, a Geography student of the University of Ibadan, as part of the requirements for the award of a PhD degree. Your cooperation is hereby solicited in providing the following information, which will be strictly used for the research. Please be assured that whatever information you give will be kept confidential.

1.2 QUESTIONNAIRE

1.2.1 Demographic/Personal Data

Please provide the following information by filling in the appropriate answer or ticking the appropriate space:

(1) Age (in completed years).........................(2) Gender: Male.......Female........

(3) Marital Status: i) Single........ ii) Married......(4) Number of Children:...........

(5) Place of Origin: i) Home town.......................... ii) LGA............................

iii) State of Origin...

(6) Religion:............................. (7) Ethnicity:...

(8) If a non-indigene of the area, a) state your duration of stay in the locality (in weeks)....

b) time of the year when you usually come........................... c) number of visits made within the last 12 months......................... d) settlements passed through or stopped-over during the visits (in chronological order)..

....

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(9) Highest level of education attained: i) Nursery....... ii) Primary....... iii) Secondary................ iv) Polytechnic/College of Education.........v) University..........vi) Others (specify) .... vii) None........

(10) Occupation

a) Have you worked before? i) Yes....... ii) No....... iii) if 'Yes', what type of work did you do? (specify)..........iv) for how long did you work?(specify)........... v) were you a paid worker or self-employed? (specify)...............................

b) what is your present occupation?.......................................i) what is your annual income from this occupation(in Naira)? .... what is the best estimate of your income from all sources during the past 12 months (in Naira)?..

1.2.2 Socio-economic/Environmental Risk factors

1) Have you ever been infected with TB? i) Yes........ii) No..... iii) if 'Yes', at what age were you diagnosed with the disease?..
2) Have you ever visited a health centre to treat TB? i) Yes.......ii) No........iii) if 'Yes', how many times? ....
3) Have you ever stayed with a tuberculosis-infected person? i) Yes........ ii) No.......... iii) if 'Yes', for how long?... iv) what is your relationship with the infected person? ....
4) Has any member of your family ever been infected with TB? i) Yes......ii) No......... iii) if 'Yes', who? ....iv) for how long? ....v) was it cured?.......
5) What do you think causes TB? ....
6) Is TB curable? i) Yes........ ii) No........ iii) Give reasons for your answer.. ....
7) i) What are the possible sources of medication? ....
   ii) Which ones have you tried?...
   iii) iii) Give your reasons for trying them...
8) How accessible are the health centres in your area of origin? i) Travel time....... ii) Distance (km)......................iii) Cost (Naira)... iv) Attitudes of Health Personnel...
9) How accessible are the health centres in this area? i) Travel time.....................

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ii) Distance (km)......................iii) Cost (Naira)..

iv) Attitudes of Health Personnel ....

1) Have you ever smoked cigarettes? i) Yes..... ii) No.... iii) if 'Yes', how many sticks did you use to smoke per day?...............iv) at what age did you start smoking?................................ v) are you still a smoker? vi) Yes....vii) No....... viii) if 'No', for how long have you stopped smoking?........... ix) how many members of your family smoke?...........................
2) Have you ever been diagnosed of any lung-or heart-related disease? i)Yes..... .ii) No....... iii) if 'Yes', when was that?................................iv) for how long have you been with the disease?...
3) In the past 12 months, did you ever suffer from any illness? i) Yes......ii) No....... iii) if 'Yes', specify the type(s)..
4) Compared to other people of your age, how would you describe your state of health? i) Very poor health…......ii) Healthy…....iii) Perfectly healthy........
5) Are you satisfied with your state of health at the moment? I) Yes........... ii) No................... iii) Give reasons for your response...
....
6) Do you graze your animals on the fields? i) Yes......... ii) No......... iii) if 'Yes', how often?...........................iv) do you envisage any health risk associated with that? i) Yes............... ii) No........... iii) if 'Yes', explain how..........................
7) Do you sleep in the midst of your animals? i) Yes........... ii) No......... iii) if 'Yes', how often?...........................iv) do you envisage any health risk associated with that? i) Yes............... ii) No............ iii) if 'Yes', explain how..
8) How often do you clean your surroundings?..
9) What is the source of your drinking water? i) Pipe-bone tap.......... ii) Open well .... iii) Stream/river/pond ....iv) Rain harvest v) .... Others (specify) ....
10) How many members of the family usually sleep in a single room?.....................
11) How often do you take fresh unpasteurized milk or its by-products?.......................
12) In the past 12 months, did your job ever expose you to dust in the air? i) Yes.....ii) No......... iii) if 'Yes', what effect did it on your health?......................
13) How often do you visit the markets?.......................and for what reasons...

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14) How often do you attend to congregational religious obligations?......................

15) How often do you attend social functions or gatherings?...................................

Thank you

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APPENDIX II: PROJECTED POPULATION FIGURES

Note: Bolded settlements are the DOTS Centres

a) PRIMARY HEALTH CENTRE GWADABAWA

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
GWADABAWA	20	12004	22658
CHANCHA	3	1832	3458
G/JIHADI	2	668	1261
MAMMANDE	3	2024	3820
GIGANE	7	7671	14479
TAMBAGARKA	2	4737	8941
RANGANDA	4	2454	4632
ABBA DAN	1	1125	2123
BAUDA	2	847	1599
DARNA TSOLAWO	1	798	1506
BILINGAWA	1	322	608
LAHODU	1	1213	2290
FADAN KAI	1	1449	2735
TAJAYE	1	533	1006
ASARA	3	2222	4194
MAMMAN SUKA	1	1831	3456
RUMBUJE	3	1316	2484
TOZAI	1	1679	3169
TUNGAR BIZO	1	337	636
DANKADU	1	957	1806
DARNA KILIYA	1	300	566
BAMANA	1	2364	4462
SALAME	1	8633	16295
GIDAM M/RASHIDU	1	664	1253
RAKA	5	1780	3360
ABDALO	2	876	1653
ATAKWANYO	1	978	1846
MADARARE	2	454	857
LABHADI	1	1524	2877
TUDUN DOKI	1	1432	2703
TUDUN KADALE	1	831	1569
SAKAMARU	1	1704	3216
GIDAN ANAZA	1	721	1361

Source: National Population Commission (NPC), 1991and data analysis, 2010

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a) GENERAL HOSPITAL ILLELA

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
ILLELA	33	15547	29345
HURA MAKINA	1	556	1049
WAURU	3	4139	7812
GAIDAU	3	1607	3033
TOZAI	2	1679	3169
MALALI	1	791	1493
KWARMA ALKALI	1	1152	2174
SARMA TUDU	1	706	1333
HOLAI SARKIN NOMA	1	559	1055
DAN BOKA	2	1634	3084
KIRIN KWANAWA	2	1891	3569
DAMBAR KWAMAWA	1	1595	3011
KORINGO	3	718	1355
GARU	3	1621	3060
GIDAN KATTA	2	843	1591
KALMALO	3	5611	10591
KADADI	1	1617	3052
MAKINA DAN TUDU	1	512	966
AMARAWA	1	2894	5462
TUNGAN ZANGO	2	1166	2201
KILIYA	1	1435	2709
GIDAN AMAMATA	1	1072	2023
DARNA TSAULAWA	1	798	1506
BAKIN DUTSI	2	1721	3248
TUDUN GUDALE	2	831	1569
DAMBAR DIKKO	2	2045	3860
TARKE	1	1408	2658
MUNWADATA	1	1404	2650
MAKINA (MUNLELA)	1	431	814
DUKAMAJE	1	1831	3456
GARU GARI (K/ BISA)	1	1621	3060
GIDAN CHIWAKE	2	1028	1940
HARAGAWA	1	962	1816
WA'IYYAKA	1	948	1789
TUDUN AYA	1	943	1780
GWADABAWA	1	12004	22658
TAFKIN TARAUNIYA	1	445	840
LUGGU HURU	1	1179	2225
MAGAJI MASASA	1	949	1791
GIDAN HAMMA	2	1616	3050

Source: National Population Commission (NPC), 1991and data analysis, 2010

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b) SPECIALIST HOSPTAL SOKOTO

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
SOKOTO	355	330895	624569
YABO	2	10235	19319
JABO	1	4654	8784
WAMAKKO	2	1038	1959
DANGE	2	6940	13099
SABARRU	1	122	230
GORONYO	10	8358	15776
KAMBAMA	2	2137	4034
TSEHE	1	1794	3386
SABON BIRNI	3	13490	25463
HAMMA'ALI	5	1224	2310
ACHIDA	5	7483	14124
TANGAZA	6	3963	7480
SANYINNA	4	7293	13766
RABAH	3	6641	12535
SILAME	4	3674	6935
SHUNI	4	2817	5317
GANDI	3	10594	19996
BODINGA	6	8533	16106
WURNO	2	19445	36703
HORO BIRNI	1	31018	58547
ALKAMMU	2	3851	7269
TAMBAGARKA	1	4737	8941
DANDIN MAHE	1	3147	5940
GADA	4	5071	9572
BIRNIN KEBBI	1	63101	119104
KIRI	3	1161	2191
ZUGANA	1	3398	6414
KUBODU	1	1039	1961
KADADI	1	1010	1906
BURMAWA	1	518	978
ALIERO	1	10561	19934
BUNZA	1	17576	33175
LUKUYAWA	1	890	1680
WABABE	1	2195	4143
MAHUTA	1	6061	11440
JANBAKO	1	6885	12996
ZURU	1	13578	25629
ARGUNGU	1	35000	66063
DANKARMAWA	1	510	963
KWARGABA	1	1732	3269
GIYAWA	1	7372	13915
DONO	2	1130	2133
TOFA	1	3073	5800
GIGANE	1	7671	14479
KASARAWA	2	2760	5210
DURBAWA	2	3598	6791
SHAGARI	8	3751	7080
MALLAMAWA	1	1311	2475
KWAGGEL	2	995	1878
DANKURMI	1	5900	11136
GUSAU	1	152812	288435
BANKANU	1	2455	4634
DOGON DAJI	1	8521	16084
BUNKARI	1	3865	7295

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SPECIALIST HOSPTAL SOKOTO (Continued)

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
RARA	2	359	678
GWADABAWA	2	12004	22658
MANKERI	1	923	1742
YAR ABBA	1	2774	5236
DANAJIWA	1	402	759
ILLELA	1	15547	29345
BADAWA	1	1042	1967
GUMMI	1	30242	57082
DUNDAYE	7	1858	3507
KAURAR KIMBA	1	565	1066
SALAME	2	8633	16295
KALGO	1	1361	2569
BENGAJE	1	1091	2059
GWAMATSE	2	1454	2744
KURA	1	1535	2897
RUGGAR KIJO	1	834	1574
MARADUN	1	9434	17807
YAURI	1	15785	29794
TSAKI	1	702	1325
TAMAJIRA	1	689	1300
TORONKAWA	2	1633	3082
DOROWA	1	557	1051
DAKIN GARI	1	5388	10170
JAREDI	3	2368	4470
GIDAN GADO	1	215	406
BUI	1	1381	2607
JANGEBE	1	6186	11676
KARFEN SARKI	2	1040	1963
DINGYADI	1	1934	3650
TALATA MAFARA	1	29281	55268
KWARE	2	655 8	16336
JEKANADU	1	3400	6418
BARE	1	1693	3196
BAKURA	1	12942	24428
ANKA	1	8275	15619
BUKKUYUM	2	4254	8029
DARAYE	3	652	1231
TSAMIYA	1	2653	5008
MULLELA	1	431	814
RUGGAR LIMAN	2	1326	2503
KALAMBAINA	2	6153	11614
GANGAM	2	1816	3428
DAGYAL	1	1088	2054
KEBBE	1	4370	8248
ILLO	1	5308	10019
GWANDU	1	15214	28717
TSITSE	1	2084	3934
LAHODU	1	1213	2290
RIMAWA	1	4805	9070
GIDAN GADO	1	215	406
BUI	1	1381	2607
JANGEBE	1	6186	11676
KARFEN SARKI	2	1040	1963
DINGYADI	1	1934	3650
TALATA MAFARA	1	29281	55268
KWARE	2	655 8	16336
JEKANADU	1	3400	6418

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SPECIALIST HOSPTAL SOKOTO (Continued)

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
BARE	1	1693	3196
BAKURA	1	12942	24428
ANKA	1	8275	15619
BUKKUYUM	2	4254	8029
DARAYE	3	652	1231
TSAMIYA	1	2653	5008
MULLELA	1	431	814
RUGGAR LIMAN	2	1326	2503
KALAMBAINA	2	6153	11614
GANGAM	2	1816	3428
DAGYAL	1	1088	2054
KEBBE	1	4370	8248
ILLO	1	5308	10019
GWANDU	1	15214	28717
TSITSE	1	2084	3934
LAHODU	1	1213	2290
RIMAWA	1	4805	9070

Source: National Population Commission (NPC), 1991and data analysis, 2010

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c) COMPREHENSIVE HEALTH CENTRE, KWARE

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
KWARE	13	8655	16336
MALAMAWA	2	2354	4443
GINIGA	1	510	963
TANGAZA	2	3963	7480
TUNGA AMMA	2	461	870
S/ BIRNIN KWARE	2	1242	2344
KASGADA	1	675	1274
GIDAN JIHADI	1	668	1261
HAMMA'ALI	3	1124	2122
HAUSAWA	3	885	1670
MARABAWA	1	879	1659
KAFFE	1	2925	5521
WALAKAI	1	847	1599
GUNDUGA ALKALI	1	111 1	2097
DOBA	1	917	1731
DURBAWA	1	1598	3016
TABANNI	1	1167	2203
MALAMAWA YARI	1	1311	2475
KABANGA	1	784	1480
KALALAWA	3	1913	3611
GWADABAWA	1	12004	22658

Source: National Population Commission (NPC), 1991and data analysis, 2010

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d) GENERAL HOSPITAL BODINGA

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
DANDIN MAHE	4	3147	5940
BODINGA	46	8522	16085
DANCHADI	4	5929	11191
SIFAWA	2	4400	8305
SHAGARI	1	3751	7080
GWADABAWA	1	12004	22658
KAURAR MIYO	1	1023	1931

Source: National Population Commission (NPC), 1991 and data analysis, 2010

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e) GENERAL HOSPITAL YABO

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
YABO	3	10235	19319
TSIBIRI	1	1085	2048
SANYINNA	3	7293	13766
TAGULE	1	361	681

Source: National Population Commission (NPC), 1991 and data analysis, 2010

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f) GENERAL HOSPITAL DOGONDAJI

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
SABON BIRNI	1	13490	25463
DOGON DAJI	5	8521	16084
MARUDA	2	1561	2946
LODI-GYASA	2	922	1740
JABO	2	4654	8784
HILIYA	1	759	1433
ELA	1	366	691
KAMBAMA	1	2137	4034
KEBBE	1	4370	8248
BADUSAI	2	435	821
GANUWA	1	2166	4088
GABTU	1	3255	6144
SABAWA	1	1353	2554
NABAGUDA	2	995	1878

Source: National Population Commission (NPC), 1991 and data analysis, 2010

UNIVERSITY OF IBADAN

g) GENERAL HOSPITAL GUMMI

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
FALALE	1	4423	8348
GUMMI	9	30242	57082
DAKI TAKWAS	1	4013	7575
GYALENGE	1	6500	12269
TULMI	1	1324	2499
GAMBANDAR GODABE	1	1058	1997
BARIKIN DAJI	1	1396	2635
DAN AWO	1	722	1363
LESHI	1	1365	2576
YOLAR MASU	1	609	1149
NASARAWAR KAIFI	1	1996	3767
YAR GUSAU	1	1238	2337
GWALLI	2	1626	3069
GALKO	1	1164	2197
ADARAWA	3	1796	3390
GIDAN ILLO	1	1416	2673

Source: National Population Commission (NPC), 1991and data analysis, 2010

h) PRIMARY HEALTH CENTRE MAHUTA

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
MAHUTA	13	6061	11440
DAN INDO	2	1049	1980
YOKO	1	1043	1969
MARAFA	1	898	1695
DANSO GURUMACE	1	1184	2235
ASARARA	1	713	1346
KANGI	1	2551	4815
BAJIDA	4	874	1650
GERE	1	470	887
MATSERI	1	485	915
GARIN TUDU	1	1304	2461
BA'ARE	1	675	1274

Source: National Population Commission (NPC), 1991and data analysis, 2010

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i) GENERAL HOSPITAL SHANGA

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
GIRON MASA	4	2566	4843
KESSAN	1	895	1689
DUGU RAHA	3	2139	4037
SAWASHI	2	1328	2507
HUNDEJI	7	1041	1965
SHANGA	9	1916	3616
DUGU TSOHO	4	3673	6933
S/GARIN DARGA	1	609	1149
YAURI	2	15785	29794
ZABARMAWAN	1	780	1472
BELA UWA	2	805	1519
TAKWARE YAHAYA	1	628	1185
SANTI	2	652	1231
RUNTUWAN MAHUTA	2	581	1097
RUNTUWAN GANWO	1	297	561
KALA-ZARIA KALA	1	5004	9445
TUNGAR GALADIMA	2	235	444
RUNTUWAN UJE	1	537	1014
(KAIWA (KAWARA	3	1169	2207
HORI GORI	1	762	1438
TUNGAR TSAMIYA	2	424	800
YARBESSE	3	3156	5957
ATUWO	3	1376	2597
GANWO	2	1338	2525
TURU BAKIN	1	799	1508
GEBBE	2	1881	3550
SAKACE	1	1080	2039
TUNGAR NOMA	1	846	1597
RUNTUWAN T/GIWA	1	537	1014

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

j) MARTHA BAMAIYI GENERAL HOSPITAL ZURU

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
DOMO	1	473	893
ZURU	86	13578	25629
GOGADI	2	610	1151
BERE	1	470	887
AMANAWA	3	1263	2384
DONGO	4	1184	2235
ISGOGO	1	547	1032
MAGA	3	3101	5853
TAJAYE	4	336	634
GUMMI	1	30242	57082
BAGUDO	1	8350	15761
RIBAH	2	6500	12269
DUTSIN DOSA	1	400	755
UNGUWAR MUSUNE	2	504	951
JARKASA	8	364	687
BADURU	1	759	1433
MAGAJI KUNTUWA	1	742	1401
UNGUWAR KIBIYA	2	336	634
RAMUNNAI	1	719	1357
BENA	2	5256	9921
TADURGA	2	2245	4237
GOGIDI	1	610	1151
BEDI	5	1406	2654
SENCHI	2	600	1133
DABAI	5	1687	3184
UNGUWAR GOJIYA	2	1035	1954
BUKKUYUM	1	4254	8029
KUKA ZUSSUN	2	479	904
TUNGAR BAHAGO	1	1357	2561
WADAKO	1	723	1365
UHU	1	304	574
USARA	1	200	378
BAJIDA	1	874	1650
DANKO	2	1982	3741
OSIMO	1	1371	2588
KWAZGA	1	427	806
RANGE	1	713	1346

Source: National Population Commission (NPC), 1991and data analysis, 2010

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k) GENERAL HOSPITAL YAURI

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
YELWA YAURI	190	18785	35457
BIRNIN YAURI	3	2450	4624
MAKRIN	1	1569	2962
ATUWO	2	1376	2597
KWANJI	1	934	1763
KAWARA	7	1169	2207
KAOJE	3	4585	8654
SHANGA	11	1916	3616
BAGUDO	4	8350	15761
KOKO	2	14673	27695
NGASKI	12	2066	3900
ZAMARE	5	940	1774
GEBBE	2	1881	3550
WARRAH	2	7161	13516
BESSE	1	4903	9254
MAJE	1	453	855
MAHUTA	1	6061	11440
ZAGGA	1	6554	12371
DAKI TAKWAS	1	4013	7575
DADIN KOWA	1	596	1125
DAKIN GARI	2	503	949
BAKIN TURU	1	799	1508
GIRON MASA	1	2566	4843

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

l) GENERAL HOSPITAL WARRAH

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
KAOJE	1	4587	8658
CHIPAMINI	3	971	1833
GAFARA	2	955	1803
YADI	1	432	815
WARRAH	16	7161	13516
AUNA	2	141 6	11591
LIBATA	5	2213	4177
NGASKI	5	2066	3900
RAISHE	2	720	1359
KWANGA	3	907	1712
LOFA	1	518	978
INTAKIYA	1	537	1014
UTONO	2	767	1448
GIDAN KWANO	2	869	1640
BAKARI	1	716	1351
KOSO	1	441 1	2720
SALKA	3	165 10	19187
IBETO	1	160 7	13515
WAWU AUNA	1	656	1238
GWADE	1	680	1284
MALALE	1	841	1587
SHAGUNU	1	752 1	3307
GETEGI	1	975	1840

Source: National Population Commission (NPC), 1991and data analysis, 2010

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m) GENERAL HOSPITAL NEW BUSSA

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
SHAFADI	1	800 2	5285
NEW BUSSA	29	383 21	40361
MALALE	1	841	1587
BABANNA	2	219 3	6076
WAWA	3	991 4	9421
SHAGUNU	1	752 1	3307
LUMA	1	342 1	2533
LABARARU	1	85	160
KORO	1	548	1034
GADA OLI	1	549	1036
SWASHI	1	986 1	3749
PISSA	1	011 1	1908
YUMU	1	575 1	2973
GUFFANTI	3	117	221
TAMANAI	2	696	1314

Source: National Population Commission (NPC), 1991and data analysis, 2010

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n) RURAL HOSPITAL AUNA

SETTLEMENT	TB Prevalence	1991 Census Figure	Projected 2010 Population
KOSO	2	441 1	2720
KAWO	1	484 1	2801
WAWA	1	991 4	9421
AUNA	6	141 6	11591
TUNGAR JIKA	1	025 2	3822
SABON GARI	3	900 2	5474
SALKA	1	165 10	19187
GETEGI	1	975	1840

Source: National Population Commission (NPC), 1991and data analysis, 2010

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Appendix III: Computed Distance of Settlements to Sample DOTS Centres

Note: Bolded settlements are the DOTS Centres

PRIMARY HEALTH CENTRE GWADABAWA

Settlement	Distance to DOTS Centre (Km)
GWADABAWA	1.00
CHANCHA	5.67
GIDAN JIHADI	1.33
MAMMANDE	26.04
GIGANE	15.59
TAMBAGARKA	17.10
RANGANDA	1.73
D/ABBA	22.27
BAUDA	29.19
DARNA TSAULAWA	28.60
BILINGAWA	11.98
LAHODU	12.16
FADAN KAI	20.24
TAJAYE	7.44
ASARA	11.86
MAMMAN SUKA	23.79
RUMBUJE	13.78
TOZAI	38.86
TUNGAR BIZO	5.43
DANKADU	30.93
DARNA KILIYA	27.21
BAMANA	31.24
SALAME	19.47
TUNGAR M/RASHIDU	13.16
RAKA	13.72
ABDALO	5.39
ATAKWANYO	9.93
MADARARI	11.14
LABCEDI	13.28
TUDUN DOKI	7.95
TUDUN KAKALE	10.25
SAKAMARU	12.47
GIDAN ANAZA	26.09

UNIVERSITY OF IBADAN

GENERAL HOSPITAL ILLELA

Settlement	Distance to DOTS Centre (Km)
ILLELA	1.00
HURA MAKINA	15.05
WAURU	21.27
GAIDAU	7.15
TOZAI	9.96
MALALI	8.12
KWARMA ALKALI	47.50
SARMA TUDU	21.39
HOLAI SARKIN NOMA	21.96
KIRIN KWANAWA	29.47
DAMBAR KWAMAWA	20.76
KORINGO	15.41
GARU	13.50
GIDAN KATTA	10.27
KALMALO	7.31
KADADI	27.04
MAKINA DAN TUDU	15.76
AMARAWA	2.49
TUNGAN ZANGO	18.25
KILIYA	28.57
GIDAN AMAMATA	25.60
DARNA TSAULAWA	30.21
BAKIN DUTSI	4.64
TUNGAR GUDALE	3.00
DAMBAR DIKKO	21.32
TARKE	17.24
MUNWADATA	5.92
MAKINA (MUNLELA)	26.03
DUKAMAJE	56.16
GARU GARI (KASUWAR BISA)	14.10
GIDAN CHIWAKE	13.04
HARAGAWA	16.68
WA'IYYAKA	25.85
TUDUN AYA	12.40
GWADABAWA	42.93
TAFKIN TARAUNIYA	15.88
LUGGU HURU	18.65
MAGAJI MASASA	12.47
GIDAN HAMMA	26.31

Source: National Population Commission (NPC), 1991and data analysis, 2010

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SPECIALIST HOSPITAL SOKOTO

Settlement	Distance to DOTS Centre (Km)
SOKOTO	1.00
YABO	46.32
JABO	69.58
WAMAKKO	15.97
DANGE	25.28
SABARRU	6.65
GORONYO	63.22
KAMBAMA	50.51
TSEHE	11.65
SABON BIRNI	130.75
HAMMA'ALI	15.19
ACHIDA	20.88
TANGAZA	46.98
SANYINNA	59.70
RABAH	28.67
SILAME	44.57
SHUNI	13.91
GANDI	56.07
BODINGA	26.44
WURNO	31.63
HORO BIRNI	39.60
ALKAMMU	16.23
TAMBAGARKA	33.78
DANDIN MAHE	39.51
GADA	71.96
BIRNIN KEBBI	132.17
KIRI	78.31
ZUGANA	57.47
KUBODU	29.93
KADADI	89.27
BURMAWA	14.91
ALIERO	118.99
BUNZA	170.48
LUKUYAWA	26.37
WABABE	27.78
MAHUTA	171.09
ZURU	182.90
ARGUNGU	88.07
DANKARMAWA	61.62
KWARGABA	36.43
GIYAWA	42.21
DONO	1.00
TOFA	22.25
GIGANE	47.13
KASARAWA	12.42
DURBAWA	10.22

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SPECIALIST HOSPITAL SOKOTO (Continued)

Settlement	Distance to DOTS Centre (Km)
SHAGARI	56.58
MALLAMAWA	7.52
KWAGGEL	47.43
GUSAU	182.40
BANKANU	26.01
DOGON DAJI	82.66
BUNKARI	38.92
RARA	41.72
GWADABAWA	31.56
MANKERI	19.92
YAR ABBA	11.84
DANAJIWA	18.09
ILLELA	73.96
BADAWA	19.57
GUMMI	99.05
DUNDAYE	5.98
KAURAR KIMBA	14.58
SALAME	38.90
KALGO	59.45
BENGAJE	51.39
GWAMATSE	24.55
KURA	51.52
RUGGAR KIJO	46.30
MARADUN	124.94
YAURI	253.70
TSAKI	7.50
TAMAJIRA	86.78
TORONKAWA	57.21
DOROWA	49.35
DAKIN GARI	205.22
JAREDI	35.73
GIDAN GADO	84.12
KARFEN SARKI	84.29
DINGYADI	20.87
TALATA MAFARA	98.41
KWARE	17.95
JEKANADU	32.54
BARE	57.07
BAKURA	110.87
ANKA	121.99
BUKKUYUM	98.78
DARAYE	22.77
TSAMIYA	53.54
MULLELA	49.64
RUGGAR LIMAN	3.15
KALAMBAINA	6.75

UNIVERSITY OF IBADAN

SPECIALIST HOSPITAL SOKOTO (Continued)

Settlement	Distance to DOTS Centre (Km)
BUKKUYUM	98.78
DARAYE	22.77
TSAMIYA	53.54
MULLELA	49.64
RUGGAR LIMAN	3.15
KALAMBAINA	6.75
GANGAM	51.64
DAGYAL	32.73
KEBBE	119.47
ILLO	237.94
GWANDU	93.33
LAMBAR TURETA	56.27
LAHODU	31.72
RIMAWA	86.67

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

COMPREHENSIVE HEALTH CENTRE KWARE

Settlement	Distance to DOTS Centre (Km)
MALAMAWA	1.00
GINIGA	11.55
TANGAZA	9.32
TUNGA AMMA	37.92
SABON/B KWARE	3.51
KASGADA	2.92
GIDAN JIHADI	8.69
HAMMA'ALI	13.40
IHIN HAUSAWA	10.33
MARABAWA	14.88
KAFFE	5.21
WALAKAI	72.64
GUNDUGA ALKALI	84.19
DOBA	12.13
DURBAWA	6.93
TABANNI	20.26
MALAMAWA YARI	53.63
KABANGA	25.24
KALALAWA	30.24
GWADABAWA	4.38
SOKOTO	13.95
DANDIN MAHE	17.95

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL BODINGA

Settlement	**Distance to DOTS Centre (Km)**
BODINGA	1.00
DANCHADI	9.46
SIFAWA	3.44
SHAGARI	30.32
GWADABAWA	56.24
KAURAR MIYO	2.36

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL YABO

Settlement	Distance to DOTS Centre (Km)
YABO	1.00
TSIBIRI	20.86
MAZAREN GABAS	3.35
SANYINNA	18.00
TAGULE	108.63
JAREDI	12.38
SABON BIRNI	172.06

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL DOGON DAJI

Settlement	Distance to DOTS Centre (Km)
DOGON DAJI	1.00
GYASALODI	26.43
JABO	18.15
HILIYA	20.63
ELA	36.69
KAMBAMA	48.90
KEBBE	39.29
BADUSAI	7.07
GANUWA	19.63
SABAWA	15.24
NABAGUDA	10.22

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

PRIMARY HEALTH CENTRE MAHUTA

Settlement	Distance to DOTS Centre (Km)
MAHUTA	1.00
UCHIRI	4.60
DAN INDO	22.14
TUNGAN RUNGA	8.16
MARAFA	98.16
ASARARA	52.34
KANGI	40.16
BAJIDA	15.96
MATSERI	39.96
GARIN TUDU	47.75
BA'ARE	11.91
DOMO	66.93

Source: National Population Commission (NPC), 1991and data analysis, 2010

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MARTHA BAMAIYI GENERAL HOSPITAL ZURU

Settlement	Distance to DOTS Centre (Km)
ZURU	1.00
GOGADI	9.24
BERE	14.68
AMANAWA	5.02
ISGOGO	13.95
GUMMI	85.83
UNGUWAR MUSUNE	7.03
UNGUWAR KIBIYA	14.42
TADURGA	19.69
BEDI	13.05
SENCHI	12.73
DABAI	7.86
GOJIYA UNGUWAR	4.49
GIRON MASA	67.31
SAWASHI	71.81
HUNDEJI	73.51

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL SHANGA

Settlement	Distance to DOTS Centre (Km)
SHANGA	1.00
DUGU TSOHO	10.55
YAURI	45.59
ZABARMAWAN	3.95
BELA UWA	2.91
TAKWARE YAHAYA	13.92
SANTI	16.04
RUNTUWAN GANWO	1.00
TUNGAR GALADIMA	4.93
RUNTUWAN UJE	10.87
(KAIWA (KAWARA	12.43
HORI GORI	28.90
TUNGAR TSAMIYA	5.67
YARBESSE	32.26
ATUWO	6.72
GANWO	44.59
GEBBE	5.50
SAKACE	21.23
TUNGAR NOMA	34.04
RUNTUWAN	11.51
TUNGAR GIWA	

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

GENERAL HOSPITAL YAURI

Settlement	Distance to DOTS Centre (Km)
YELWA YAURI	1.00
BIRNIN YAURI	9.47
MAKRIN	17.06
ATUWO	60.68
SHANGA	44.96
KOKO	70.00
NGASKI	47.43
ZAMARE	14.60
SALKA	65.39
GEBBE	36.11
WARRAH	17.78
BESSE	58.55
MAHUTA	83.15
DAKIN GARI	117.26
GIRON MASA	29.51
CHIPAMINI	60.78
GAFARA	48.88
YADI	70.15

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

GENERAL HOSPITAL WARRA

Settlement	Distance to DOTS Centre (Km)
WARRA	1.00
LIBATA	4.37
NGASKI	22.63
RAISHE	7.53
KWANGA	2.53
LOFA	29.01
UTONO	39.16
GIDAN KWANO	14.94
BAKARI	5.08
WAWU GARI	15.19
KOSO	33.14
SALKA	45.26

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

APPENDIX IV: COMPUTED DISTANCE OF SETTLEMENTS TO CONTROL DOTS CENTRES

Note: Bolded settlements are the DOTS Centres

GENERAL HOSPITAL GWANDU

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Gwandu	75	1.00
Wararin Magaji	3	17.73
Yole Gorama	3	6.80
Dogondaji	8	17.62
Gora Kwaccido	3	14.29
Dalijan	12	15.94
Malisa	3	10.38
Wararin Zoramawa	3	21.37
Adarawa Waziri (Tungar Sule)	3	32.00
Kambaza Fulani	4	12.38
Sabon Birni	1	13.52

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

GENERAL HOSPITAL ALIERO

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Aliero	86	1.00
Bunza	1	56.05
K/Zana	4	9.94
Margai	1	35.11
Jiga	4	6.49
Alassan	1	16.84
Alelu	2	11.34
Marmaro	1	7.98
Jega	7	13.91
Gumbai	2	32.28
Arausaya	1	19.63
B/Mallam	1	20.16
Maruda	1	38.63
Ruggar Dawa	2	36.58
K/Hausawa	1	20.00
Kalbanga	1	25.80
Lagga	6	13.83
Tambuwal	5	27.28
Sabiyal	1	60.04
Maza Goma	1	17.39
Guddare	1	28.39
Andarai	1	44.96
Gumbin Dari	5	6.55
Mammawa	2	10.84
Gungulu	1	6.15
U/Amadu	2	7.35
Dumbegu	1	15.98
Danwarai	7	8.44
Gulmare	1	14.33
Tungar Bauna	1	42.55
Naman Goma	1	42.48
Gehuru	2	9.06

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

GENERAL HOSPITAL ARGUNGU

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Argungu	125	1.00
Alwasa	6	16.58
Umara	8	20.71
Mera	5	24.34
Bayawa	5	21.60
Felende	4	7.54
Bui	3	45.32
Yeldu	3	29.43
Tiggi	2	11.71
Awade	2	13.99
Sarka	2	8.86
Lailaba	2	12.27
Kangiwa	2	74.86
Jarkuka	3	47.03
Mashe	2	6.40
Kwaido	2	35.73
Bachaka	2	62.55
Indire	2	22.76
Bubuche	2	17.96
Sakwabe	2	56.86
Sawwa	3	25.50
Yamana	5	25.09
Gidan Agoda	1	5.98
Gatawa	1	154.45
Garu	1	17.10
Goron Dikko	1	60.91
Bagaye	1	14.69
Unguwar Jaja	1	48.51
Lema	1	36.42
Zagabu	1	27.80
Gwazange	1	1.76

UNIVERSITY OF IBADAN

` GENERAL HOSPITAL ARGUNGU (Continued)

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Gwamatse	2	34.72
Gwabare	1	20.34
Dagawa	2	17.49
Towon Tsoro	1	14.57
Dikko Sule	1	42.90
Abdu Hassan	1	34.29
Mafaskara	1	44.00
Tudun Dabagga	1	82.67
Gamuzza	1	15.26
Rimau	1	42.58
Tungar Rafi	1	39.27
Nasarawa Kamfani	1	67.97
Bunza	1	92.34
Birnin Tudu	1	27.74
Dafashi	1	27.17
Shafarma	1	5.58
Augi	1	18.11
Aliero	2	49.80
Kare	2	53.68
Walkam	2	40.69
Koko	1	146.96
Unguwar Mallamai	1	97.13
Unguwar Daura	1	10.65
Unguwar Kibiya	1	74.33
Rafin Tsaka	1	103.62
Lugga Gyado	2	15.48
Awashaku	1	52.83
Tungar Magaji	1	31.09
Unguwar Goje	1	54.28
Zazzagawa	1	17.88

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

GENERAL HOSPITAL JEGA

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Jega	69	1.00
Zabarmawa	1	31.29
Kulunkoji	1	7.59
Suru	1	38.35
Unguwar Madi	1	21.34
Alkalauza	1	8.60
Dangamazi	1	7.91
Jandutsi	1	17.29
Kwarakwasa	1	40.70
Unguwar Nagindi	2	8.94
Botoron Gadi	1	28.11
Lugu	2	7.32
Gamjegi	1	15.54
Dumbegu	1	10.59
Alelu	2	9.68
Katanga	1	13.40
Maiyama	2	13.69
Andarai	1	34.48
Tungar Buzaye	2	5.97
Tsirarrai	1	12.09
Damwarai	2	6.20
Kuberi	1	13.35
Mayalo	1	17.09
Ganda Samu	1	12.81
Jandutsi	1	17.21
Kyarmi	2	5.23
Burmin Malam	1	20.03
Diggi	2	42.47
Sambawa	1	14.73
Gomozon Yari	2	31.53
Danmagaji	2	7.91
Basaura	1	18.11
Kulunkoji	1	7.58
Kawasa	1	88.84
Gindi	2	1.86

Source: National Population Commission (NPC), 1991and data analysis, 2010

UNIVERSITY OF IBADAN

AMANAWA LEPROSARIUM

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Amanawa Dutsi	2	1.00
Dambuwa	2	11.10
Shuni	12	3.95
Dange	8	8.41
Amanawa Rafi	1	1.58
Kwandi	1	1.95
Kwannawa Bagarai	1	6.40
Makera Dabagi	2	3.76
Dabagin Dugui	1	3.70
Dutsin Zaki	1	4.39
Tudun Shuni	3	5.26
Ruggar Dutsi	2	6.34
Tsehe	1	10.07
Ruggar Giwa	1	7.60
Tuntube	2	6.96
Kauraren Tuntube	1	5.80
Kwannawa	5	8.72
Marina Gidan Mande	1	3.43
Gyalaude	1	5.13
Ruggar Dubu	1	6.91
Battar Hausawa	2	3.44
Battar Runji	3	4.53
Dogon Marke	1	5.11
Kwanar Kimba	1	5.59
Makerar Lungu	1	2.11
Kusu	2	2.16
Dilingu	1	5.16
Hausare	1	14.64
Boolere	1	14.03
Wababe	2	11.51
Katsira	1	7.01

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AMANAWA LAPROSARIUM (Continued)

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Rudu Dikko	2	4.92
Rudu Gidan Doki	2	6.05
Kwaragon Magaji	2	8.70
Kindiru	2	8.10
Dankilo	1	6.57
Jurga	1	11.65
Kaurar Magaji	3	12.61
Adarawa Fajaldu	1	11.45
Sokoto	7	16.79
Maberar Iddi	1	13.33
Dundaye	1	23.25

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL BINJI

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Binji	5	1.00
Kalbadi	1	2.62
Sabon Gari	1	3.66
Takalafiya	1	9.27
Daddale	1	5.30
Dalijan Hausawa	1	5.51
Dalijan Rugga	2	6.30
Matabare	2	9.92
Baragada	1	7.21
Kabawa	1	6.70
Gidan Na-Rini	1	9.14
Ginjo	1	9.45
Samawa Marina	4	14.41
Bakawa	2	6.05
Diddiba Tudu	1	11.39
Dan Maliki	1	15.80
Bunkari	2	11.93
Fisna	2	5.23
Aliyon Magaji	1	9.85
Kandeza	2	8.41
Soro	2	12.77
Gawazzai	1	8.41
Diriri	1	9.04
Kura	2	18.34
Kalgo	4	26.76
Gomozo	2	37.49
Maikulki	3	6.74

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL KAMBA

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Kamba	62	1.00
Maigwaza	1	28.85
Fana	5	34.73
Banizumbu	3	22.21
Kyangakwai	15	8.70
Gungu-Kuka	3	35.13
Gumunde	2	58.27
Bengu	3	35.98
Dolekaina	8	15.87
Garin Gyado	1	123.01
Bani Goru	2	35.73
Tungar Bage	1	36.11
Shiko	2	21.65
Gezah	2	33.47
Sabon Gari	1	26.13
Tungar Rafi	2	27.81
Bui	1	109.37
Malam Yaro	1	3.71
Goru	2	26.55
Y/Gawo	1	41.38
Yalawa	1	28.70
Unguwar Hassan	1	29.72
Baguma Kwara	1	3.08
Arewa	1	78.89

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL TURETA

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Tureta	4	1.00
Lambar Tureta	4	8.21
Boka Hammada	2	24.37
Tsamiya	1	16.43
Loha	1	13.06
Gidan Tudu	1	19.37
Gidan Sule	2	3.56
Ranfandiya	2	9.51

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL MAIYAMA

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Maiyama	9	1.00
Tsalibi Mayamle	1	6.23
Faggada	3	9.79
Giwa Tazo	2	5.88
Lelaba	2	75.60
Achikaratu	2	9.86
Kaurar Sani	1	55.76
Mungadi	5	27.86
Kuberi	1	12.37
Kurun-kudu	1	12.65
Karaye	2	33.10
Hurumin Kurya	1	7.27
Saran Dosa	2	9.29
Yauri	1	144.51
Hore	1	21.97
Rowan Fili	2	12.52
Kyarmi	1	16.16
Kamba	1	83.76
Zara Birni	2	6.65

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL TANGAZA

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Tangaza	6	1.00
Gidan Madi	2	8.26
Sutti	1	3.56
Rini	1	5.95
Sidingo	1	103.82
Kalenjeni	1	14.94
Gwabro (Sabro)	1	29.29
Ayama	1	4.30
Masallachi	1	24.31
Kambana	1	29.01
Jigo	1	29.25
Kwalajiya	2	15.92
Bachaka	3	86.07
Gwadabawa	1	32.12

Source: National Population Commission (NPC), 1991and data analysis, 2010

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PRIMARY HEALTH CENTRE, GANDE

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Gande	11	1.00
Silame	1	5.50
Gumki	2	5.15
Karangiya	3	8.38
Majo Sanyina	1	12.86
Kabikeji	1	12.19
Gumburaje	3	10.64
Labani	2	11.21
Tullere	1	13.17
Jekanadu	1	15.41
Gittarawa	1	10.70
Kaya	1	4.93
Mali	1	3.36
Tungar Fako	1	15.84
Katami	1	17.52
Dan Kade	1	17.52
Rugunniya	1	13.50
Kwaggel	1	15.33
Binjin Muza	1	18.75

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL WURNO

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Wurno	39	1.00
Illelar Liman	1	2.07
Dabagin Buba	1	1.25
Dimbiso	1	8.29
Duhuwar Marannawa	3	7.28
Gidan Kimba	2	3.77
Dinawa	3	5.41
Munki	1	9.57
Kwargaba	9	8.67
Koliyal	3	14.40
Marnona	3	11.33
Dabagin Basau	1	8.90
Lugu	4	4.84
Dan Baso Kyal-kyal	1	3,24
Tambagarka	5	46.84
Lahodu	5	10.72
Gidan Modi	1	11.75
Yarlabe Ajema	2	17.47
Tungar Dankemu	1	4.54
Hammaáli	2	16.01
Darna Dankadu	2	24.12
Doba	2	12.84
Gidan Kaya	1	9.59
Darna Kiliya	4	24.07
Gwadabawa	1	22.21
Yar Gada	3	11.58
Lukuwa	3	7.85
Kaurar Chimmola	1	6.72
Chimmola	4	6.92
Tajaye	1	16.39
Huchi	8	5.09
Salame	3	10.10
Zugana	5	27.25
Mammande	3	19.34
Mammande Jema	2	19.41
Marabawa	1	29.49
Danwaru	4	27.34
Sokoto	4	32.94

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL RABAH

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Rabah	25	1.00
Kogogon Rijiya	2	4.09
Tofa	6	7.53
Gawakuke	1	11.18
Tursa	1	22.77
Rarah	6	19.26
Maikujera	1	3.51
Gidan Buwai	1	13.02
Chachu	1	8.50
Goronyo	2	40.28
Achida	4	13.17
Gandi	6	31.21
Saketa	2	14.64
Garin Liman	1	22.03
Gidan Dare	1	10.28
Tsamiya	5	29.67
Gwaddodi	4	10.11
Kurya	2	24.39
Badawa	1	14.71
Angamba	1	8.13
Dan Banda	1	46.02
Yar Tsakuwa	2	43.96
Dawakawa	3	21.24
Sangiwa	2	34.12

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL GADA

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Gada	15	1.00
Bigal	4	6.99
Sabon Garin Gada	1	1.37
Zangon Barhe	1	6.16
Gidan Hashimu	1	23.45
Tsitse	1	27.47
Gadabo	1	15.35
Kiri	2	13.40
Kwarman Dikko	1	12.06
Dan Tudu	1	6.30
Kaffe	4	10.47
Gidan Gyado	6	15.00
Gidan Ayuba	1	29.76
Kyadawa	2	6.47
Rafin Duma	1	16.48
Ingaboro Kware	2	13.73
Kadassaka Kiliya	1	11.31
Kadassaka Babba	1	13.40
Holai	1	17.94
Tajaye	1	29.29
Alibawa	1	9.47
Sahel Magori	2	7.92
Chari Zango Adam	1	5.54
Kalaba	1	1.57

Source: National Population Commission (NPC), 1991and data analysis, 2010

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GENERAL HOSPITAL GORONYO

Settlement	TB Prevalence	Distance to DOTS Centre (Km)
Goronyo	13	1.00
Illela Huda	1	5.91
Mariri	1	9.32
Sabon Garin Dole	2	13,52
Bijeje	3	14.12
Giyawa	1	21.25
Kiraren Gari	2	3.17
Taloka	3	2.72
Shinaka	3	13.33
Dantudu	1	22.64
Kojiyo	1	6.66
Bare	1	7.15
Tagamawa	1	9.66
Kwakwazo	2	4.43
Maihurde	1	31.92
Gidan Barau	1	11.55
Tuluske	3	4.84
Kagara	2	9.91
Zugana	1	20.86
Takalmawa	1	42.83

Source: National Population Commission (NPC), 1991and data analysis, 2010

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APPENDIX V: DISTANCE OF CONTROL DOTS CENTRES TO ROUTE OF MIGRATION

DOTS Centre	Number of Settlements where Patients come from	Recorded TB Prevalence	Distance to Route of Migration (Km)
GH KAMBA	24	133	148
GH ARGUNGU	61	240	54.7
GH ALIERO	31	166	53.7
GH JEGA	35	116	76.6
GH GWANDU	11	132	20
GH MAIYAMA	19	41	77.8
PHC GANDE1	19	35	43.8
GH TANGAZA	15	26	31.2
GH BINJI	27	48	37.3
GH GORONYO	20	46	44.5
GH GADA	24	58	37.8
GH TURETA	9	18	65.3
AMANAWA LEPROSARIUM	42	91	12.2
GH RABAH	24	81	28.4
GH WURNO	38	147	19.5

Source: National Population Commission (NPC), 1991and data analysis, 2010

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