AN EVALUATION OF SPATIAL ACCESSIBILITY TO HEALTHCARE FACILITIES IN GARKI, FEDERAL CAPITAL TERITORY, NIGERIA, USING GEOGRAPHICAL INFORMATION SYSTEM

BY

DIRISU, Fatai Obozekhai
M.TECH/SSSE/2007/1722

DEPARTMENT OF GEOGRAPHY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA.

DECEMBER, 2010

AN EVALUATION OF SPATIAL ACCESSIBILITY TO HEALTHCARE FACILITIES IN GARKI, FEDERAL CAPITAL TERITORY, NIGERIA, USING GEOGRAPHIC INFORMATION SYSTEM

BY

DIRISU, Fatai Obozekhai
M.TECH/SSSE/2007/1722

A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLOGY (M.TECH) IN GEOGRAPHY (ENVIRONMENTAL MANAGEMENT)

DECEMBER, 2010

DECLARATION

I DIRISU, FATAI OBOZEKHAI, declare that this thesis work was written by me and has not been presented wither in whole or part, for the award of any post graduate degree anywhere else. All literature cited have been duly acknowledged in the reference.

....
DIRISU FATAI OBOZEKHAI

11/2/2011
DATE

CERTIFICATION

This thesis titled: An Evaluation of Spatial Accessibility to Healthcare Facilities in Garki, Federal Capital Territory, Nigeria, using Geographical Information System by: DIRISU Fatai Obozekhai (M. Tech./SSSE/2007/1722) meets the regulations governing the award of the degree of Master Technology (M. Tech.) of the Federal University of Technology Minna and is approved for its contribution to scientific knowledge and literary presentation.

Dr. H.A. Shaba Supervisor	17/06/2011 .... Signature & Date
Dr A.S. Abubakar Head of Department.	17/06/2011 .... Signature & Date
Prof. M. Galadima Dean, School of Science & Science Education	28/6/2011 .... Signature & Date
Prof. (Mrs)S.N. Zubairu Dean, Postgraduate School.	.... Signature & Date 5/7/2011

DEDICATION

In loving Memory of my Late Father Mallam Abdulraman Dirisu May His Gentle Soul rest in Peace. Who lived and died in tireless sacrifice for his progeny.

ACKNOWLEDGEMENTS

I cannot pay back the efforts, time and energy my project supervisor Dr. H.A. Shaba put into my project work, but to show that I appreciate thank you sir, May God in His infinite mercy reward you abundantly, Amen. Also, I recognize the efforts of my new Head of Department Dr. A.S. Abubakar. I would like to express my gratitude and appreciation to our co-ordinator Mr. Saidu Salihu for his expertise in impacting God given knowledge and experience into us. God bless you Sir. I cannot help but acknowledge the contribution of my loving mother, Mrs. Habibat Abdulrahman over the years, whom God has used as a vessel of blessings unto me in many ways.

My gratitude cannot be expressed in words. My special appreciation goes to my dearest wife, Mrs Ojo Anna Fatai, Mr Abdulrahman Abdulfatai and Ms Khairat Abdulfatai for their immense spiritual and financial assistance, thank you very much. Also my brothers, sisters, relatives and my love ones and numerous friends. You are part of my life.

ABSTRACT

Public policy on health care provision in Nigeria over the years addresses the distribution and spatial equity question mainly at the gross or at best regional level betraying its rather narrow conceptualization of the issue of distribution. This research uses geographic information techniques to examine the spatial pattern of health care delivery facilities in Garki District in Abuja. The location of tertiary, secondary and primary health care services in Garki is presented against the background of the pattern of population and settlement location. The study also examined the utilization pattern of the available services. Interview, Questionnaire Administration and information from Federal Capital Health Management Services were adopted. The findings show that the available health care facilities in Garki are concentrated in the heart of Garki district. Conversely the other part of the area where population and settlement density are higher, there are limited healthcare facilities located in them. The inaccessibility of the available healthcare facilities has obviously affected the utilization of modern healthcare services by a vast proportion of the people in Garki. The paper concludes by recommending a policy of deliberate dispersal of health care services to other parts of the area where there are no facilities at present

TABLE OF CONTENTS

2

Page

CHAPTER TWO:

CHAPTER THREE

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Access to health is an important component of an overall health system and has a direct impact on the burden of disease that affects many countries in the developing world. Measuring accessibility to health care contributes to a wider understanding of the performance of health systems within and between countries which facilitates the development of evidence based health policies. The use of Geographic Information Systems (GIS) for the measurement of physical accessibility is well established and has been applied in many areas including transport, emergency service and health care planning. GIS applications are well suited to measuring spatial accessibility to health care as they contain the core components

Despite tremendous development in health science and technology, the health status of the majority of the world's population remains poor hampering overall human development, the capacity of individuals to realize their potential for a productive life, and the human effort to live and die with dignity (Kleczkowski et al 1994). The popular parlance that health is "wealth" is based on the fact that good health is a precondition for socio-political and economic development in any nation.

The provisions of health facilities in various parts of the country comprises one of the main objectives of health care delivery system so that a large percentage of the people would have easy access to health services. Researchers have revealed that health facilities are often located at a distance far from people they are meant to serve. The result of this is that health facilities are not patronized as one would have expected. Many types of health care facilities are required in a health system. Best known perhaps are hospitals for the bed-care of seriously ill patients. There are also separate facilities for ambulatory care, pharmacies, and laboratories among others. The location, size and design are important features of health facilities and have a major influence on their effectiveness.

1.2 Problem Statement

One of the major problems facing man is the issue of health, as the saying goes that 'health is wealth' this implies that once an individual is healthy, every other thing can follow. The accessibility to health care facilities is a major obstacle to health care delivery systems. People have died in transit between their homes and hospitals because of distance that have to be covered, before such persons get to see a doctor.

Researches have been carried out on Spatial Accessibility to Healthcare facilities but have not been adequate because, the issue of accessibility is an issue of location in space. Spatial access is a measure of access to facilities using geographic features such as barriers to travel and pathways or roads on which people can travel. When health facilities are being planned an optimal location would take both of these access factors as considerations (Wang and Luo 2003). Many studies focus on the distance or travel time to the nearest facility for a population without considering the population that is being served. Population data representing the social dimension is used in conjunction with the distance to a health facility to find what populations have better access to those facilities considering these dimensions can lead to a spatially equal epidemiological profile for a city. This can only be done effectively using GIS and its relationship with population in the area.

1.3 Purpose and Significance of Study

Access to primary healthcare is recognized globally as an important facilitator of overall population health. In Nigeria the majority of research and policy efforts to improve access and eliminate disparities in healthcare have focused on costs. Consequently we know quite a bit about the relationship between healthcare facilities and distance, accessibility and utilization rates. However, we know surprisly little about how other barriers to healthcare affect utilization rates among these less well understood barriers is geographic availability and accessibility of primary care providers. This knowledge deficit can now be more aggressively addressed, thanks to recent advances in the field of Geographic Information Systems.

Accessibility to health care facilities has been globally identified as a major indicator of development. The importance of adequate health care facilities in providing sustainable development cannot be overemphasized. Convergence of opinions agreed that lack of basic health care facilities have led to inefficiency in production, declining productivity, reduced life expectancy and increased infant mortality rate. Increased productivity by individual in all sectors of the economy depend on the health condition of the labour force. Improved healthcare and quality of life depends to a great extent on the availability of, and accessibility to healthcare facilities at convenient distances.

The inequitable geographic distribution of healthcare resources has long been recognized as a problem in Nigeria. Traditional measures, such as a simple ratio of supply to demand in an area or distance to the closest provider, are easy measures for spatial accessibility. However the former one does not consider interactions between patients and providers across administrative borders and the latter does not account for the demand side, that is, the competition for the supply. With advancements in GIS, however, better measures of physical accessibility in relation to distance covered and road network can be done using proximity analysis.

1.4 Scope and Limitation of Study

The scope of the study is to assess the spatial accessibility of the people to healthcare services in Garki district. The research was limited to the location, the number of hospitals, availability of healthcare workers and distance covered by persons who need healthcare facilities.

1.5 Aim and Objectives

The aim of the study is to assess the physical spatial accessibility to health care services in Garki district, Abuja.

The specific objectives are to;

i. Assess the pattern of distribution of health care facilities in Garki district.

ii. Assess the distance covered by the residence in relation to health facilities

iii. Identify loop holes in the distribution of healthcare facilities in the district.

iv. Identify equitable distribution of health care facilities.

v. Identify the ration of population to Health workers

. Discuss factors responsible for the distribution of such facilities

Description of Study Area

ı city, capital of the country, located in the Federal Capital Territory. Abuja officially ed Lagos as the capital in December 1991, after 15 years of planning and construction. :ity is located in a scenic valley of rolling grasslands in a relatively undeveloped, :ally neutral area. Thus, planners hoped to create a national city where none of Nigeria's al and religious groups would be dominant. A large hill known as Aso Rock provides the kdrop for the city's government district, which is laid out along three axes representing ıe executive, legislative and judicial branches. Government agencies began moving into the ıew capital in the early 1980s, as residential neighborhoods were being developed in outlying areas. Abuja has an international airport and is linked to other cities in Nigeria by a network of highways.

1.6.1 Historical Background of F.C.T

The historical evolution of Federal Capital Territory could be traced back to February 1976, with the promulgation of Decree No.6 entitled "Federal Territory Decree" from then on, the area measuring 8000 sqkm carved out from the three contributing states of Niger, Plateau and Kwara, ceased to be part of their former respective states. The journey began in 1981 when the then president Alhaji Shehu Shagari gave a directive that Federal Capital Territory (FCT) should completely take over all portions of land areas ceded to FCT. Just immediately,

·deral Capital Authority took portions of the land ceded and with a proper administrative ıcture.

Geography

a Nigeria's new capital city is located in the middle of the country. The Federal Capital ory has a land area of 8,000 sq km it is bounded in the north by Kaduna State, on the by Niger State, on the East and South-East by Plateau State, and on the South-West by State. It falls within latitude 7^0 25'N and 9^0 20' N of the equator and longitude 5^0 45' 7^0 39'.

ıja is in tune with nature with abundant hills, highlands and other distinguishing features ıt make it a delight to behold. A scene that cannot be missed about Abuja is the coming together of the Savanna grassland of the North and the middle belt with the richness of the tropical rain forests of the South.

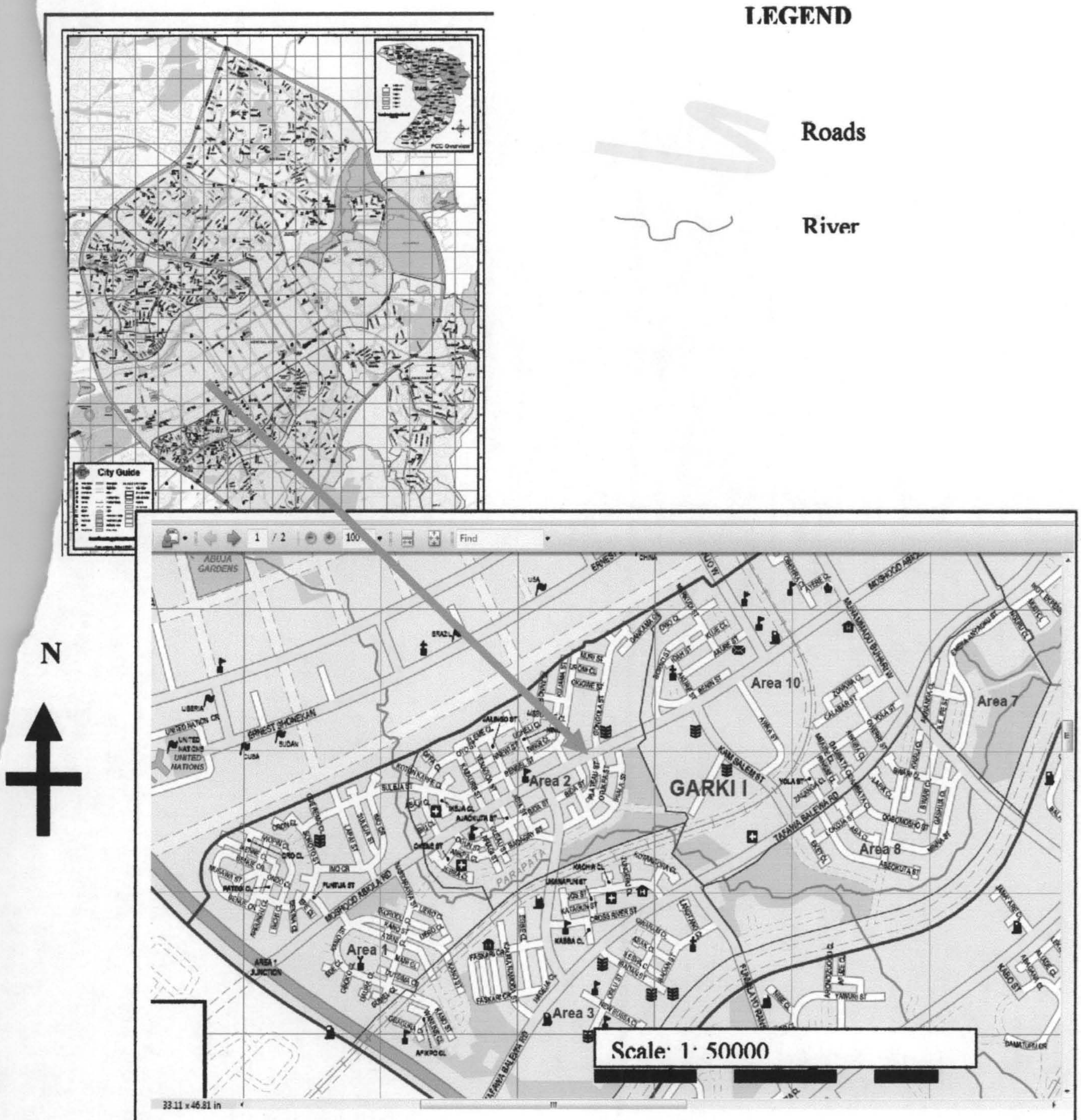


Fig 1.1: District map of Abuja showing study Area

;.3 Weather and Climate

: FCT has two distinct seasons namely the rainy season that begins around March and through October and the dry season which begins from October and ends in March. ever, within these seasons is a brief harmattan season that is occasioned by the north-rade wind and the attendant dust haze, increased cold and dryness.

ner conditions in Abuja is influenced by its location within the Niger-Benue trough on vindward side of the Jos Plateau and at the climate transition zone between the tially humid south and the sub-humid north of the country. The climates dictate of the ' are essentially from the South-west to the North-west due to the rising elevation from : Gurara valley in the South-west to the Bwari Aso hills and the Agwa- Karu hills to the North-east.

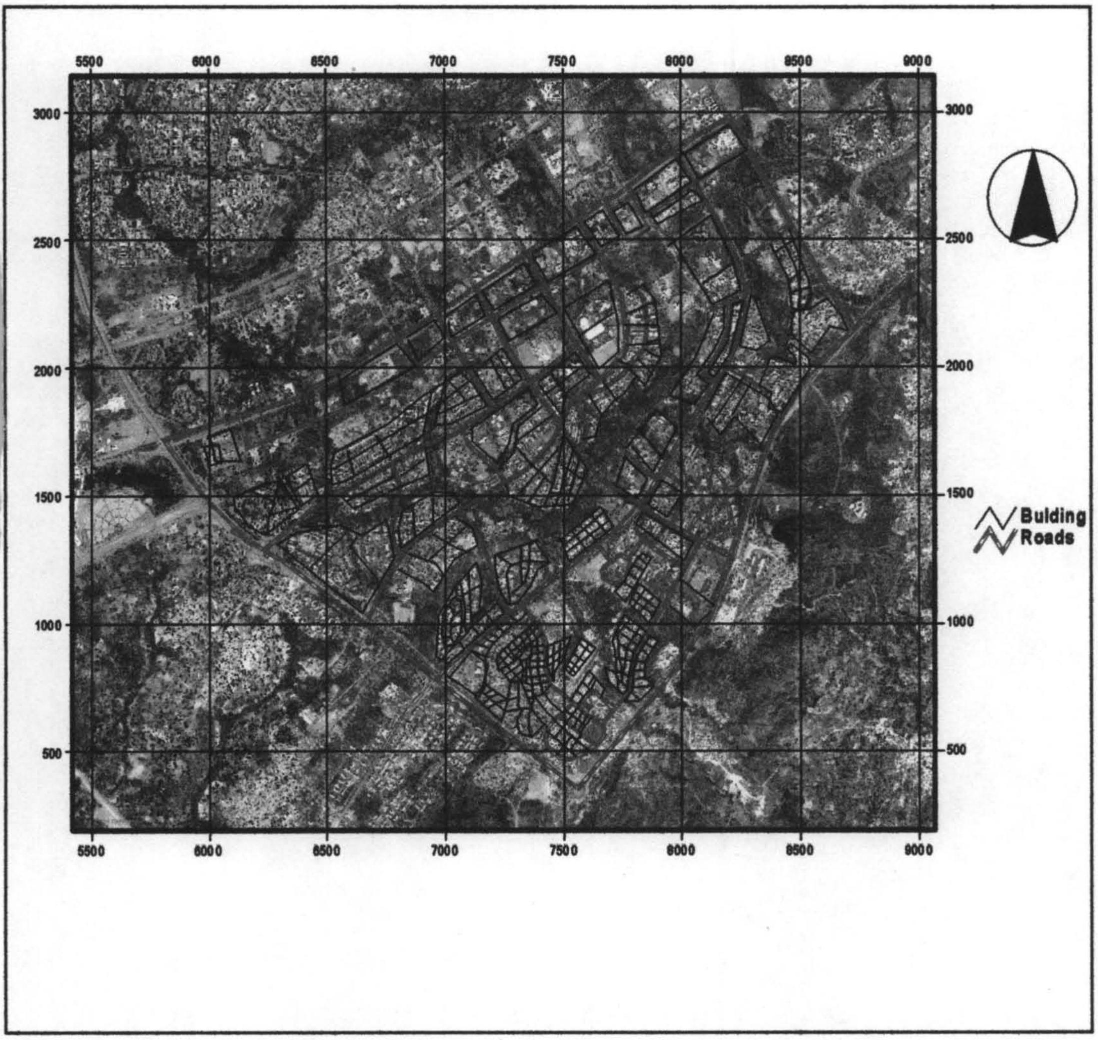
1.6.4 Garki District

The Garki District is the area in the southwest corner of the city, (fig 1.1) having the Central District to the north and the Asokoro District to the east. The District is subdivided into units called "Areas". Garki uses a distinctive naming convention of "Area" to refer to parts of Garki. These are designated as Areas 1 to 11. Garki II is used to differentiate the area from Garki Area 2. Visitors may at first find this system of names confusing.

Garki is presently the principal business district of Abuja. Numerous buildings of interest are located in this area. Some of them include the General Post Office, Abuja International Conference Center located along the busy Herbert Macaulay Way, Nicon Luxury Hotel formally known as Abuja Sofitel Hotel and Le Meridian), Agura Hotel and Old Federal cretariat Complex Buildings (Area 1).

a 2 is mainly used for residential purposes, although a zoological garden as well as Garki pping Center are located there too. Several banks and other commercial offices are ed along Moshood Abiola Way in Area 7. The Headquarters of the Nigerian Armed es, namely Army Headquarters, Airforce Headquarters and Navy Headquarters are all ted in the Garki District.

tallest building in this district is the Radio House, which houses the Federal Ministry of ormation and Communications, and the Federal Radio Corporation of Nigeria (FRCN). e Nigerian Television Authority (NTA) Stations and Corporate Headquarters are also based in Garki. The Federal Capital Development Authority (FCDA) which oversees and runs the Administration of the Federal Capital Territory has it offices in Garki.



1:1000

Fig 1.2: Image of study area.

CHAPTER TWO

LITERATURE REVIEW

s chapter explains basic concepts and measurements of access, provides health care archers with some historical background, outlines the major questions concerning raphic accessibility to health care, describes recent developments in GIS and spatial 'sis, and presents examples of promising work. Emphasis will be on the health spatial ibutions and the population characteristics that influence access.

Defining Access

cess to healthcare has multiple definitions, and its meaning in a given context is too often ssumed (Khan 1994). The most basic problem is that it is both a noun referring to potential for healthcare use, and a verb referring to the act of using or receiving healthcare. This leads to confusion between ability to get care, the act of seeking care, the actual delivery of care, and indicators thereof. Concepts and communication become clearer if we think of access in terms of stages and dimensions. The two broad stages are "potential" for care delivery, followed by "realized" delivery of care. Potential exists when a needy population coexists in space and time with a willing and able healthcare delivery system. Realized care, sometimes referred to as actualized care follows when all barriers to provision are overcome. (Khan 1994).

A number of barriers can impede progression from potential to realized access. Penchansky & Thomas, (1981) have grouped barriers into five dimensions: availability, accessibility, affordability, acceptability and accommodation. The last three have received the most ion of Researchers, Government and NGO in the United States of America in recent s. They are essentially a spatial, and reflect health care financing arrangements and ural factors. However, the first two dimensions are spatial in nature.

ilability refers to the number of local service points from which a client can choose. lability reflects travel impedance (distance or time) between patient location and service ts. While the distinction between availability and accessibility can be useful, in the ext of urban areas, where multiple service locations are common, the two dimensions uld be considered simultaneously. We refer to this fusion as "spatial accessibility a term t is common in the geography and social sciences literature and is gaining some favor in ne geography literature (Guagliardo et at 2004).

2.2 Spatial Accessibility

Distance to healthcare provider was recognized as a significant barrier to healthcare access in the U.S. By the middle 1970s many attempts were made to measure spatial accessibility of health service locations, identify areas of provider shortage, and reveal social disparities in Spatial accessibility in both urban and rural areas (Shammon, 1984). The issue has been on the national policy agenda since the 1967 Report of the National Advisory Commission on Health Manpower, attributed misdistribution of healthcare professionals to their preference for affluent neighborhoods. Since then work has continued for rural and mixed urban-rural areas, despite a lack of consensus on how to best measure spatial accessibility (Luo and Wang, 2003). This primary rural focus was fueled by the recognition that distance is an us impediment in sparsely populated areas, and by the alarming decline of health care .force supply in rural America (Salsberg and Forte, 2000).

cern about Spatial accessibility to healthcare providers in urban areas remains high ɜdley, Smith and Nelson Et al, 2002). However, with few exceptions, U.S. cities have not studied since the middle 1970s. One reason is that intuitive spatial indicators, which are ably appropriate for large rural geographies, are much less relevant in congested urban ;. Ironically, the waning of research on urban spatial accessibility of healthcare providers esponded with the increasing availability of powerful software and hardware necessary more valid and sophisticated urban studies. In the more recent literature there is clear evidence of social inequity in spatial distribution of healthcare providers, including primary care providers. (Barnett (1978). However, few studies have tested for an effect of spatial accessibility on actual healthcare delivery. In two studies, Fortney Et.al (2003) showed that travel distance affected the probability of utilization of mental health and alcoholic treatment services. Nattinger et al 2001 referred to Athas et al, (2000) that found increasing travel distance to be associated with decreased utilization of breast cancer treatment. Similarly, Meden et.al. (2002) showed that shorter travel distance to radiation oncology facilities was associated with lower rates of the equally efficacious but less desirable radical mastectomy treatment. Goodman have reported that greater distance from hospital was associated with lower likelihood of admission for discretionary conditions (Goodman, et al 1997) and (Teicholz, 2002). The aforementioned studies support the notion that spatial accessibility impacts probability of contact with the healthcare system.

and Friedman, (2001) found that children living in areas with lower primary care ability were more likely to travel greater distances for ACSC inpatient services, the lication being that disease rates were higher in these areas. For adults, Basu et al. (2002) Parchman and Culler (1999) found that lower primary care availability was associated higher rates of ACSC admissions. In a British study Gulliford (2002) found that lower al practitioner supply was associated with higher rates of avoidable hospitalizations. ly, in a study of mortality rates in U.S. metropolitan areas, Shi and Starfield, (2001) d that physician supply levels were negatively associated with mortality rates. withstanding these studies, much remains unknown.

is intuitive that communities located at insurmountable distances from any source of healthcare will be negatively impacted by the lack of resources. However, despite decades of attention we have surprisingly little quantitative information about the effect of spatial accessibility of care on population health particularly regarding the effect of primary care. The most basic problem is that we do not know what the most useful measure of spatial accessibility is. The best choice might vary with the circumstances, such as urbanicity, racial/ethnic composition, or economic status of the area under study. It is also reasonable to assume that population health should begin to be affected by spatial accessibility at some point of increasing availability of health care facilities. However, we do not know what that point is.

Furthermore, we do not know if there is a point of diminishing returns. The latter two issues are related to the question long asked by Dartmouth health services researchers, what is the rate of healthcare. We also do not yet know how the effect of health care spatial .sibility varies across the spectrum of disease. The literature on ambulatory care ;itive conditions (ACSCs) is inconsistent on this point. Some studies suggest that ACSCs ensitive to primary care availability, while other suggest that all disease categories are ly responsive to health care availability (Basu and Friedman, 2001; Parker and :ndorf, 2000).

: studies of spatial inequality are related to healthcare measure access based on either ght line distance or travel time distances between health services and demand points. The of cost path models has been less common than Euclidean distance. In a large urban entre such as Lima, Peru there are overpasses and bridges and presumably one way streets which impact the accessibility to services. There also may be areas where vehicle access is prohibited or impossible. In these instances a cost path raster analysis can account for traveling over areas on foot or through open areas where no formal route exists.

2.3 Measuring Spatial Accessibility

Clearly, important questions remain and much work needs to be done. Here we will focus on basic questions of spatial accessibility measurement, with emphasis on urban areas. Gesler (1986) published a complex and comprehensive taxonomy of spatial analyses for the broader field of medical geography. However, most published measures of spatial accessibility to healthcare can be classified more simply into four categories: provider-to-population ratios distance to nearest provider, average distance to a set of providers, and gravitational models of provider influence.

Provider–To-Population Ratio

is also referred to as supply ratios, are computed within bordered areas. They are the popular type of spatial accessibility measure because they are highly intuitive, the data :s are readily available, and they do not necessarily require GIS tools and expertise. are also the measurement type that has been used in the sentinel literature on ıatory care sensitive conditions (ACSCs). Ratios are computed for bordered areas, such ates, counties, metropolitan statistical areas, or health service areas. These are the ,raphic units of analysis. The numerator is some indicator of health service capacity, such ıumber of physicians, clinics, or hospital beds. The denominator is the population size ,ithin the area. This is most often taken from census files, but may be taken from insurance plan enrollment files, e.g. Medicare, depending on the population of interest. Bordered areas are then analyzed for associations between provider-to-population ratio values and some indicator of healthcare utilization (e.g. rate of immunizations) or health status (e.g. disease prevalence rates). As indicators of availability, supply ratios are good for gross comparisons of supply between large geopolitical units or service areas, and are used by policy analysts to set minimal standards of supply and to identify underserved areas (Connor Et al 1995, Schonfeld, 1972). Unfortunately, supply ratios have some serious limitations. First, they do not account for patient border crossing, which commonly occurs for small geographies such as urban census tracts and postal code areas (Connor Et al 1995). Secondly, supply ratios are blind to variations in accessibility within bordered areas. Finally, they do not explicitly incorporate any measures of distance or travel impedance. Consequently the results and interpretations stemming from bordered area studies can vary greatly depending on the size, r and configuration of the area units studied. This problem is well-known to aphers and spatial analysts as the modifiable area unit problem (MAUP).

Travel Impedance to Nearest Provider

is another very intuitive and commonly used measure of spatial accessibility. It is lly measured from a patient's residence or from a population center, such as the etric centroid of county of residence, depending on the resolution of the available data. el impedance, sometimes referred to as travel cost, is often measured in units of idean (straight line) distance, travel distance along a road and/or rail system, or mated travel time via a transportation network.

Travel impedance to nearest provider has been assumed to be a good measure of Spatial accessibility for rural areas, where provider choices are very limited and the nearest provider is also the most likely to be used. However, (Fryer 1999) have provided evidence to the contrary. Regardless of suitability for rural areas, this measure is probably not suitable for urban settings because it is insensitive to the fact that in congested areas there is usually an array of provider options at similar distance from any reference point. In fairness, all reasonable options for the potential patient should be factored into spatial accessibility measures. Therefore, travel impedance is a poor indicator of availability. Combined measures of travel impedance (accessibility) and supply (availability) are necessary to properly understand spatial accessibility. Fryer, (1999).

Average Travel Impedance to Provider

; intriguing because it is a combined measure of accessibility and availability. It, too, is ;ured from any patient or population point of interest. From that point the travel dance to all providers within a system is summed and averaged. The "system" might be or county. To the author's knowledge this measure has only been used once for a health es study (Dutt, 1986) It has two shortcomings. First, it over-weights the influence of lers located near the periphery of the study area. To illustrate for a large city, providers e northern periphery may not be a practical option for residents near the southern ›hery. Including these providers inflates the average distance, thereby decreasing arent spatial accessibility for those residents. An additional problem concerns border rossing. As with the provider-to-population ratios, patients routinely cross geopolitical boundaries to seek nearby healthcare services.

2.3.4 Gravity Models

These are also a combined indicator of accessibility and availability. A modified version of Newton's Law of Gravitation, they were initially developed to predict retail travel (Reilly, 1931) and help with land use planning (Hansen, 1959). They can provide the most valid measures of spatial accessibility if the setting is urban or rural. Gravity models attempt to represent the potential interaction between any population point and all service points within a reasonable distance, discounting the potential with increasing distance or travel impedance. Because gravity measures take into account all alternative service points, they are sometimes referred to as cumulative opportunity measures, and there is little in the primary care service ıre to suggest probable values in the meantime. Notwithstanding these caveats, the ved gravity model could prove to be very valuable for healthcare accessibility studies.

Recent Developments

ıl new spatial accessibility measurements and methods are in the works, with the ial for improving our understanding of spatial accessibility of healthcare.

Two-Step Floating Catchment Areas

ider source data are not always of the quality or spatial resolution needed for gravity-ed estimations of spatial accessibility. Sometimes only the provider's postal code is ailable, and sometimes it is not clear if the address corresponds to clinic location. In these situations the provider location is usually "assigned" to a ZIP code centroid. This loss of resolution might account for the lack of gravity-based studies of healthcare in the literature. Luo and Wang, (2003) attempted to address this problem with a derivation of the method first used by (Peng, 1997) to study urban job accessibility.

They worked with the 10-county Chicago consolidated metropolitan statistical area, which includes a great deal of rural area. They began by declaring a reasonable drive time to healthcare facilities, 30 minutes as suggested by (Lee, 1991).

In their two-step process a provider-to-population ratio is first estimated for each provider location (ZIP code centroid). The number of providers assigned to the ZIP centroid is divided by the population living within that centroid's 30-minute drive time catchment. The provider-

·pulation ratio so obtained is assigned to the entire catchment area, not just the centroid vhich it was based. This ZIP-centered catchment ratio computation is repeated for all :entroids. (In essence, the focus of the calculation is "floated" over all ZIP centroids, e the method's name.) The map resulting from this first step showed overlapping larly shaped ZIP-centered catchment areas. In sparsely populated areas with large ZIP there are also areas not covered by any catchment area, and hence having no apparent ıry care service.

ıe second step population points are the focus. Examples might include residences, tract ıtroids or ZIP centroids, depending on the resolution possible with the data. For each opulation point a spatial accessibility value is obtained by summing the provider-to-population ratios of all the first step provider catchments that overlie the point. The summed supply ratios so obtained are assigned to the entire area represented by the population point. Thus all Population areas, e.g. census tracts, have an assigned spatial accessibility value (zero in some cases).

The Spatial accessibility values are in the familiar units of provider-to-population. Luo and Wang (2003) mathematically demonstrated that their method is a special case of the (Joseph and Bantock, 1982) improved gravity model. They also show that the method takes care of the geopolitical border-crossing conundrum, and they make a strong case that this kind of work can improve or inform efforts to redefine health.

Luo and Wang (2003) recognize that the method has limitations. While geopolitical borders are well handled, the drive time catchment borders are themselves artificially sharp. Spatial ıccessibility near the periphery of the catchment is as high as at the center, and drops to zero st over the line. They performed sensitivity analyses to determine how drive times ·sholds ranging from 20 to 50 minutes affected variation in estimated spatial accessibility. change was gradual, with longer drive times producing less variation. However, this itivity test is less relevant than one that would reveal the association of spatial ssibility with utilization rates, were such data available.

.4.2 Compound Gravity Model

This unpublished model is being developed for the study of spatial accessibility of healthcare services in New Mexico by the University Of New Mexico Division Of Government Research (DRG), under contract for the New Mexico Health Policy Commission and Laurence Spear, personal communication. It is similar to the improved gravity model of (Joseph & Bantock, 1982), described above. However, reference points for provider influence and population influence (i.e. "need") are the spatial accessibility – ZIP code centroids. All persons and providers within the ZIP are assigned to the spatial accessibility point. For the compound gravity model spatial accessibility is expressed as a population-to-provider ratio, and is estimated for each ZIP point. It is a trivial matter to reverse the numerator and denominator to achieve the familiar provider-to-population ratio.

The numerator is a simple gravity model of population influence at the ZIP point. The denominator is a simple gravity model of provider influence at the spatial accessibility point.

In both terms distance decay, is a weighting scheme with three levels. The 35-mile radius around the reference point is assumed to be a friction-free zone. Hence all providers and residents in this zone are fully weighted, i.e. multiplier is 1.0. Providers and residents outside · 100 mile radius are considered inaccessible and receive a zero weight. Providers and rsons in the intermediate zone are discounted by the inverse square of their distance from reference point. The New Mexico team is applying this spatial accessibility model to the ly of hospital beds, general dentists, and registered nurses, as well as primary care sicians. They recognize that resolution is lost by working at the ZIP code geography el. There are also concerns about assuming equal accessibility within the 35-mile range, rticularly in urban areas, and applying the spatial accessibility distance decay scheme to a variety of health service types.

2.4.3 Kernel Density Method

Guptill's, (1975) married gravity and provider ratio methods in his study of Detroit physician locations. He created a continuous density layer from these points to represent physician accessibility across the entire city. (A density surface is a mathematical relative of classic gravity formulations.) Guptill (1975) overlaid his physician density layer with neighborhood borders. This permitted him to calculate the average physician density for each neighborhood. It was then a simple matter to estimate neighborhood physician-to-population ratios by dividing the community's average physician density by its population. Patient border crossing was accounted for because the density calculation often referred to as a "smoothing" process allocated each physician's availability into all neighborhoods that could reasonably rely on that physician.

Another method Guagliardo, (2004) uses an approach that is free of the compromises Guptill found necessary spatial accessibility, given the limitations of computing power and data in he early 1970s. His research was able to include all medical specialties relevant to primary re and was not forced to group physicians into single point locations such as ZIP centroids. ther, he analyzed them at street address resolution. He began by creating a continuous map er representing the density of primary care providers. Density layers are made of small ls (one tenth square mile in our case) covering the entire study region. The provider sity value associated with each cell is an estimate of spatial accessibility at the cell's nter. He used the "Gaussian kernel" method to calculate the density value of each cell. This s a preprogrammed option in the ArcGIS spatial Analyst module.

The Gaussian kernel method allocates provider capacity to the cells underlying the cone in such a way that cells near the cone center receive higher values of service capacity (i.e. accessibility), and those near the periphery of the cone receive very little. In other words, a cell's accessibility value is inversely related to its distance from the cone's center. The density values of all cells covered by the cone sum to 1.0. Provider cones frequently overlap, either partially or fully, as in the case of physicians belonging to the spatial accessibility practice. Cells in these overlapping areas receive an accessibility score (density value) that is the sum of contributions from all overlying cones. Therefore the summed cones above a large practice can be quite peaked. As a measurement refinement, a given provider's cone volume (service capacity) can be adjusted for any number of factors

There is a long history in Nigeria. of interest in local provider supply and travel distance. However, the role of these factors in maintaining population health would be better appreciated if researchers and policy makers gave consistent and due consideration to the various stages and dimensions of healthcare access. A simple taxonomy of access studies, an bring these dimensions and stages into relief, and help researchers to refine questions and ther data in the most appropriate manner. The taxonomy helps to clarify where spatial :essibility studies fit in the broader scheme of access studies.

ost researches have dealt with simple distance to nearest provider, or provider-to-opulation ratios, i.e. supply levels, within bordered areas. These have been useful for rural areas and for large-scale geographies, where they have linked distance or supply with rates or odds of healthcare utilization. However, these methods have significant limitations. Measures of supply level are only appropriate for suitably large geographies and cannot detect variations in supply within large bordered areas. Measure of distance or travel time to nearest provider ignore the potential service of providers that may be located only a short distance further. Neither of these measures is spatial accessibility satisfactory for congested urban areas, where most of the population resides. The result is that we have a relatively small literature with respect to the geography of healthcare and many very basic questions remain unanswered.

To surmount these problems researchers are beginning to combine the concepts of distance and supply under the rubric (Spatial accessibility). This is a timely development, as the geographic information systems spatial accessibility necessary to exploit these newer methods are becoming more powerful and easier to use. There are at least three new measures of spatial accessibility under development. All have a mathematical relation to the classic gravity decay formulations that have been used in the social sciences for decades, but which are not easily applied to the data commonly available for healthcare accessibility esearch. As a group they are improvements on previous methods. Yet none is without its vn problems, and researchers would be hard-pressed to choose from among them. A grand ıdy comparing their relative sensitivities to healthcare utilization rates is needed to sort ings out.

should be noted that nearly all healthcare spatial accessibility studies to date, whether based on simple or complex measures, have been limited to

the exploration of social inequity in access, or the impact of spatial accessibility on healthcare utilization. The body of work will be greatly advanced when we begin to precisely quantify how the spatial accessibility of health care actually impacts population health. This is a challenge made more difficult by recent regulations to protect patient privacy, including patient street address. Nonetheless, concerted efforts are needed to overcome these barriers in order to obtain health data at the very fine spatial resolutions needed. The payoff is potentially very great.

2.5 Spatial Accessibility to Healthcare Facilities in Nigeria

Access to health services is difficult to define. It is a multidimensional process that in addition to the quality of care, involves geographical accessibility, availability of the right type of care for those who need it, financial accessibility, and acceptability of service. Geographic accessibility, the distance that must be traveled in order to use health facility, may present an important barrier of access to health services. Studies in developing countries have presented strong evidence that physical proximity of health service can play an mportant role in the use of primary healthcare. In Nigeria, we have demonstrated that ·iving distance and driving time are important predictors for accessibility to healthcare :ilities models. It is hypothesized that long distance can be a significant obstacle to ıching health facilities, and a disincentive even to trying to seek care.

ſhe recent advances of Geographic Information Systems (GIS) have provided an important tool for healthcare planning particularly in measuring access to health services. Major progress was made in industrialized countries where the detailed data inputs such as detailed road network are available For example, Brabyn and Skelly used cost path analysis in order to determine the minimum travel time and distance to the closest hospital via road network in Lagos. More recently there was an attempt to produce a single index for the overall access to health services from combined physical access to the resources and the amount of resources available. Application of such methods in Nigeria, however, remained constrained by the lack of data inputs even in a hard copy form. In Nigeria roads are unpaved and adopted by convenience for travelling on foot or by vehicle. There is no well-established and functioning public transport system in many areas in Nigeria. Instead measuring access to health services in Nigeria remains imprecise and relies mostly on asking patients about the time and distance they travelled although most patients are not accustomed to watches. Additionally, acute (emergency) and preventative medical services are often taken together, which risks conflating two different challenges where physical barriers to care are different.

Driving distance and travel time is difficult to obtain in countries where there is a lack of well-established transport system or developed road networks. Straight-line distances are asily obtained but the relationship between straight-line distance and driving distance or avel time as in the case of Nigeria is not clear.

CHAPTER THREE

3.0 MATERIALS AND METHODS

The term methodology refers to the philosophy of the research process. This embraces the values and assumptions that serve as a rationale for research and standards or criteria used for interpreting data and reaching conclusions .

The method adopted in the spatial accessibility to healthcare facilities in Garki District such as proximity analysis and use of questionnaires is discussed in this chapter.

3.1 Data Type

3.1.1 Global Positioning Systems (GPS) Data

The GPS is a device that is used to get information about absolute location of a place. This information includes the longitudinal and latitudinal position (coordinates) of the place with respect to the earth surface. The coordinates of the study area and the locations of all accessible healthcare centers were collected using the GPS. The data that were generated from the GPS were used for boundary demarcation for the study area Equipment used for spatial data and attribute data capture are;

- A global positioning system (GPS GARMIN 12)
- A digital camera
- Landsat Image

3.1.2 Reconnaissance Survey

A physical assessment of the study area was carried out to see for certain the operations and major challenges of healthcare facilities distribution in the area. This is necessary to have first hand information of the study area and make informed decision on the state of distribution of healthcare facilities in the area, and to note the distribution of the healthcare facilities to aid data collection and management.

3.1.3 Questionnaire

A total of 250 copies of questionnaires were administered to residents and healthcare workers for the purpose of getting information about the health state of the area. 150 copies of the questionnaire went to the residents while 100 were for health workers within Garki district. Random sample method was adopted. Information like, distance to hospital, numbers of doctors and Nurses, number of patients per day. Etc.

3.1.4 Personal Interview

Some residents of Garki district were selected arbitrarily and were asked questions on their own assessment of the healthcare facilities in the area. This is different from the questions that were asked in the structured interview.

3.1.5 Population

The population of the area was sought from the National Population Commission. 2006 census figures were used for the area.

3.2.0 Software

ArcView 3.2a was used to create a digital road network and structures map from an IKONOS image of 2008. The image was digitized and a digital road network of the area was generated. Having digitized the map, the GPS values for all healthcare facilities was then imputed into the map and their locations were identified on the map. Proximity analysis was then used to access the proximity of residents to healthcare facilities in the area.

Fig 3.1 Digitized image of study area

3.2.1 Data Processing

The field survey aspects involve the use of GPS to capture X and Y coordinates of the Garki. With this computer assisted surveying method the quality and integrity as well as the completeness of the data are ensured.

The positions in terms of spatial data X and Y coordinates of the map were taken before on-screen scanning and digitization in order to provide spatial information about the project area. In this study, two types of data were captured.

3.2.2 On–Screen Digitizing

Unlike the manual digitizing that produces a vector data, in on-screen digitizing the hard copy map is first scanned, scanner produce raster data and the scanned image is imported into digitizing software environment as raster image, was digitized on-screen, some times referred to as "head on" digitizing, the features from the scanned map are digitized using a standard mouse.

The image was geo-referenced or geo-registered so as to correlate with the scanned map, before digitizing and the tracing of the features done until a composite map like the one being traced is produced.

3.2.3 Georeferencing

Handling spatial information requires the establishment of a spatial reference system to which all spatial measurements must relate. The primary function of the map is to portray accurately real-world features that occur on the curved surface of the earth.

The images were georeferenced using the roadmap of Garki for 2008 and its environs with its coordinates. Maps was produced with the process popularly known as map-to-spatial data registration

3.2.4 Layer Creation

In the course of digitizing, layers are being created. Each layer is thematic and reflects either a particular use or characteristics of the landscape. The layer concept is helpful since it reminds us that many geographical features overlap with one another. The layers created include roads, healthcare facilities and distance to each healthcare facility.

A layer may be different form another by name. The layer for this project was created to suit the type of features intended to be shown on the map to avoid job duplication, when all the features were completed the entire drawing was saved after digitizing, so that it can be taken to the appropriate GIS software (ArcView GIS 3.2a) which provides a unifying environment for both the spatial and attribute data.

3.2.5 Attribute Data Creation

Attribute data used for a GIS is created and stored in a relational database package and later linked to their corresponding objects in the GIS environment or it could be created directly in GIS environment.

3.2.6 Arc View GIS Format

ArcView is one of the latest uses of maps to analyze geographic information. You can use it to create your own geographic data. Once the map is made, it is easy to add tabular data (attribute data) to the map, so that you can display query summarize and organize your data geographically. The utility map was saved on AutoCAD 2007 software and transported to the

ArcView GIS 3.2a software as a new project. The layers from the AutoCAD drawing were in this case organized as themes, these themes was then converted to shape while, which was saved in same project file for easy access. The themes for the purpose of this project were created to suit the feature intended to be on the database.

3.2.6.1 Field Work

The field surveying aspect of the project involved the use of GPS to determine the X, Y of the various locations of the utilities The correctness of the positions of the distributions health care centre on the map in relation to their actual positions on the ground was also ensured through physical inspection and observation.

For the GSM base-station, their spatial location in terms of X and Y, attributed location were determined through observation and some personal interview, their spatial and attribute location were determined using on the spot observation and personal interview.

The spatial and attribute information acquired were collected and analyzed to its full extents, such information contributes not only to efficient services, but also to the operation and maintenance of assets and to the sensible planning of extension and new works.

3.2.6.2 Buffer Zone Generations

Buffering was performed for all the referenced healthcare centers according to the initial deterministic rules (constraints) set for each individual resident layers and set back areas were identified. The ArcView Boolean module was used combined a set of binary maps generated from buffered themes by applying different types of Boolean operators such as "AND", or "OR" etc. operator for areas where all conditions are satisfied or unsatisfied.

3.2.6.3 Others

References were made to relevant literatures and existing information about the study was sourced to make up the thesis.

3.3 Presentation of Results

The data collated from the questionnaire after extraction is presented in form of tables and charts for easy comprehension and understanding were produced. The software used for the charts and data presentation is Excel one of the packages in Microsoft office. Other charts from ARCVIEW GIS are also presented to explain the issues under study.

CHAPTER FOUR

4.0 RESULTS

The result of data generated and analysis carried out are given in this chapter.

4.1 Name and Location of Healthcare Facilities in Garki

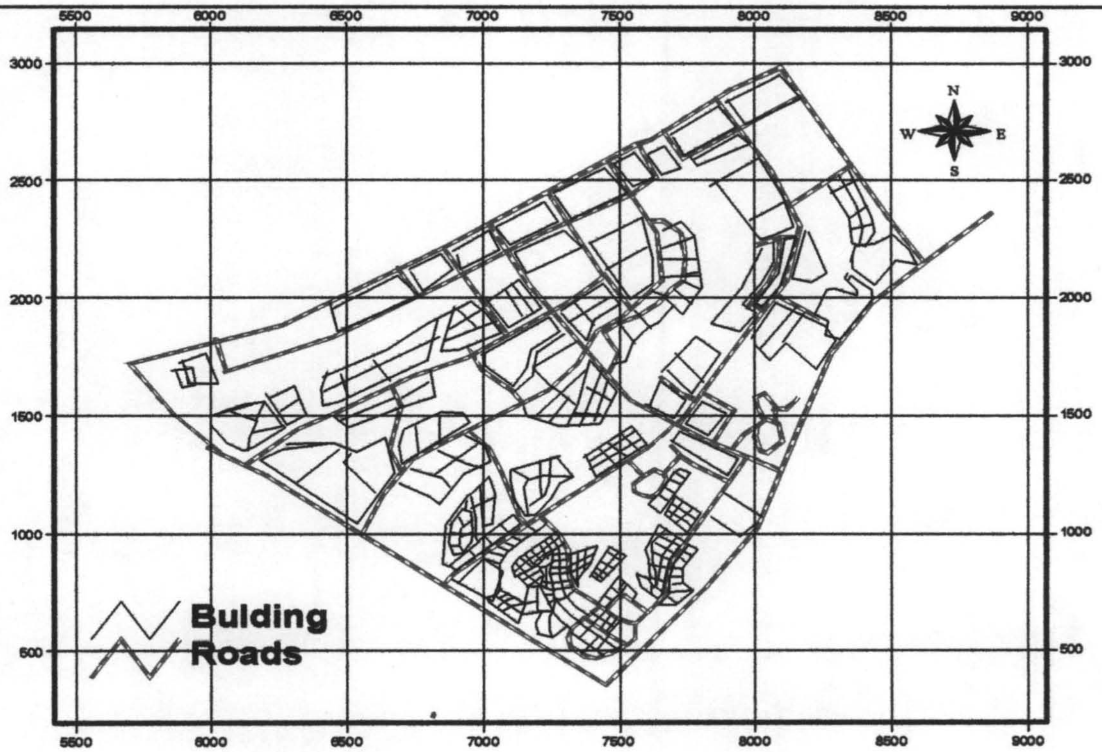
Table 4.1 is the list of healthcare facilities located in Garki district, the capacity of the hospital, number of doctors and nurses in each healthcare facility.

Table 4.1 Name and Location of Healthcare Facilities in Garki

Shape	ID	Name Of Healthcare	Location	Year of Construction	Purpose	Capacity	No. of Doctor	No. of Nurses
Point	1	Convening Medical Clinic	Garki 11	2001	Hospital	18	3	8
Point	2	Prolfa Hospital	Garki 11	2000	Hospital	19	2	7
Point	3	Society for Family Planning	Garki 11	2004	Hospital	21	2	4
Point	4	Fere Prod Medical Centre	Garki 11	1998	Hospital	24	2	5
Point	5	Abuja Clinic	Garki 11	2000	Hospital	20	2	6
Point	6	Garki Hospital	Garki 11	2000	Hospital	21	4	6
Point	7	Federal State Hospital	Garki 11	1997	Hospital	20	3	6
Point	8	Vic Pharmacy	Garki 11	2002	Hospital	6	2	6

4.2 Spatial Structure of Garki District

Fig 4.1 Show the road net work and the building in Garki District which include the residential, commercial and healthcare facilities, etc.



Scale 1.1000

Fig. 4.1: Spatial Structure of Garki District

4.2 Public/Private Hospitals Database in Garki

Table 4.2 showing the data base of the public and private hospital in Garki. These comprise of name of hospitals/clinic, location either Garki I or II, year of construction, numbers of Doctors and Nurses etc. from this data base questions and answers could be generated.

Table 4.2 Public/Private Hospitals Database in Garki

Shape	ID	Name Of Healthcare	Location	Year of Construction	Purpose	Capacity	No. of Doctor	No. of Nurses
Polygon	1	Convening Medical Clinic	Garki 11	2001	Hospital	18	3	8
Polygon	2	Prolfa Hospital	Garki 11	2000	Hospital	19	2	7
Polygon	3	Society for Family Planning	Garki 11	2004	Hospital	21	2	4
Polygon	4	Fere Prod Medical Centre	Garki 11	1998	Hospital	24	2	5
Polygon	5	Abuja Clinic	Garki 11	2000	Hospital	20	2	6
Polygon	6	Garki Hospital	Garki 11	2000	Hospital	21	4	6
Polygon	7	Federal State Hospital	Garki 11	1997	Hospital	20	3	6
Polygon	8	Vic Pharmacy	Garki 11	2002	Hospital	6	2	6

4.4 Distance Between Resident and Healthcare Facilities in Garki

Fig 4.2 shows that only 11% of the population of people living in Garki district travel less than 5km before they get to a health care facility, 47% travel a distance of 1-5km before they get to a healthcare facility, 33% travel 5-10km and 9% travel 10km and above before they reach a healthcare facility. This shows that the distribution of healthcare facilities in Garki is not adequate, because patients have to travel long distances before they have access to healthcare facility.

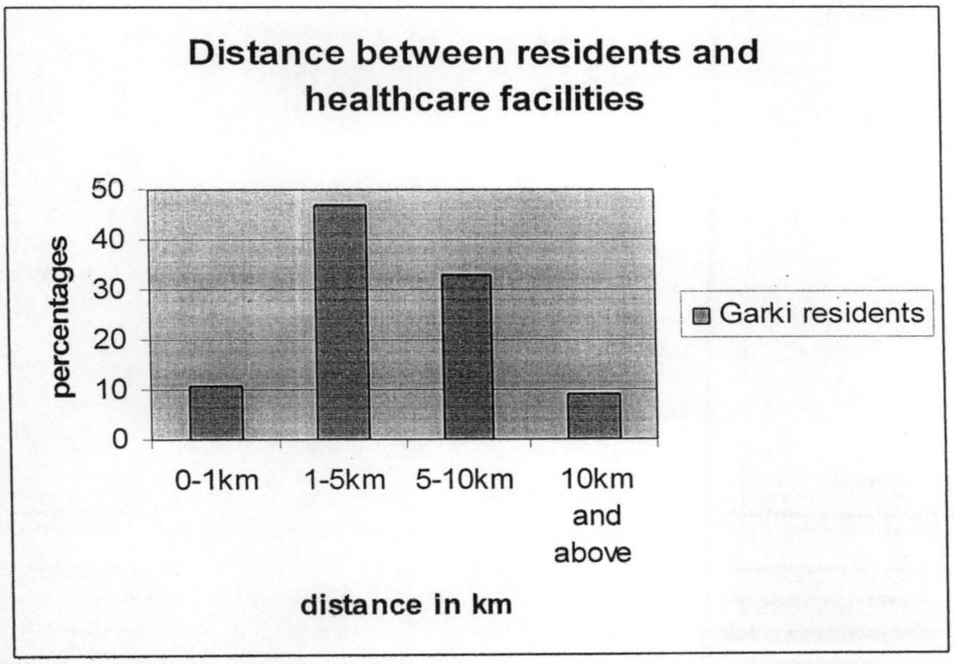


Fig 4.2 Distance Between Resident and Healthcare Facilities in Garki

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

The spatial accessibility of healthcare facilities in Garki ranging from pharmacies, clinic, primary healthcare, private and public hospitals as shown in this research work, that though, there are good roads network but facilities are not adequately located close to the people. Patients have to move long distance from their residents to hospital. At times one may decide to visit the closest clinic, even if it does not suit the type of illness suffered. Low patronage in most of the hospital because of proximity problem Fig 4.3.

Number of People to Doctors

Number of Doctors	Population (Census 2006)
106	410652

The total number of doctors to patients is 106 – 410652, this means that the average number of patients to a doctor is

$$\frac{\text{Total population}}{\text{Number of doctors}} = \frac{410652}{106} = 3874 \text{ people / doctor.}$$

Comparing this to the WHO/UN standard of 1 doctor to 100 patients shows that doctor to population ratio in Garki is not adequate. Nurses to patients ratio is also not adequate, and the total number of hospitals is grossly below average.

Providing equitable spatial access to good quality healthcare is a growing priority for health systems worldwide. Distance and location in part determine utilization of services and influence health outcomes. Unique challenges for healthcare delivery exist as a result of the large rural and remote areas where services are often limited, and distance to locations with specialized services is great. Strategic location analysis methods must be developed and used to accurately locate new healthcare services in order to provide spatial access to the greatest number of people. Specifically, more research is needed into the factors and constraints that ultimately determine the suitability of locations to host healthcare facilities than what is provided in the present study. Characteristics of future locations that has been considered include: the presence of other health services and infrastructure, availability of support services, and population demographics, among other factors. Such consideration will work to ensure that limited health resources are allocated wisely.

Whilst the information gleaned from this study is important for planning of healthcare care services delivery, the methodology is also extendable to other health services. It provides a means of rationalizing service allocation based on maximizing the number of people served within a designated health center.

5.2 Conclusion

Healthcare facilities encompass a wide range of types, from small and relatively simple medical clinics to large, complex, and costly, teaching and research hospitals. Large hospitals centers may include all the various subsidiary health care types that are often independent facilities. The old expression, "You never get a second chance to make a good first impression" applies to health care facilities. The facility conveys a message to patients, visitors, volunteers, vendors, and staff. The facility also communicates a torrent of clues about the organization and the medical care being provided there.

The design of health care facilities is governed by many regulations and technical requirements. It is also affected by many less defined needs and pressures. The most pressing of these are workforce shortages, reimbursements, malpractice insurance, physician-hospital relations, capacity, care for the uninsured, patient safety, advances in technology, and patient satisfaction p. The entire health care system is under great pressure to reduce costs, and at the same time, be more responsive to "customers". The aging are the heaviest users of health care services, and the percentage of the aging in our population is increasing significantly. At the same time, rapid technological advances, often involving very sophisticated techniques and equipment, make more diagnostic and treatment procedures available. The consequent increase in health care costs is not easily accommodated. Designers find increasing focus on limiting both construction costs and the costs of their design services, while compressing construction schedules and still meeting the highest quality standards.

5.3 Recommendations

1. Number of healthcare facilities in the district should be increased. More private clinics should be given licenses to operate healthcare centers.
2. Plots planned initially for healthcare facilities should not be used for other purposes apart from that which it is intended for.
3. Budget for healthcare facilities should be increased so as to give room for other healthcare facilities to be built by government.
4. Land policy acquisition should be made less rigid so that developers can have easy access to land meant for healthcare delivery.
5. Proximity analysis should be carried out on the district before other healthcare centers are sited so that the distribution will be even.

REFERENCES

Athas, W.F., Adams-Cameron, M., Hunt, W.C., Amir-Fazli, A and Key, C.R. (2000). Travel distance to radiation therapy and receipt of radio-therapy following breast-conserving surgery. *Journal Natl Cancer Inst, 92:269-71.*

Basu, J. and Friedman, B. (2001). Preventable illness and out-of-area travel of children in New York counties. *Health Econ, 10:67-78.*

Basu, J., Friedman, B. and Burstin, H. (2002). Primary care, HMO enrollment, and hospitalization for ambulatory care sensitive conditions: a new approach. *Med Care, 40:1260-9.*

Barnett, J.R. (1978). Race and physician location: Trends in two New Zealand urban areas. *New Zealand Geographer 1978, 34(1):2-12.*

Connor, R.A., Hillson, S.D. and Krawelski, J.E. (1995). Competition, professional synergism, and the geographic distribution of rural physicians. *Medicare, 3:1067-78.*

Dutt, A.K. (1986). Assessment of service adequacy of primary healthcare physicians in a two county region of Ohio, U.S.A: *GeoJournal, 12:443-455.*

Fortney, J., Rost, K. and Warren, J. (2000). Comparing Alternative Methods of Measuring Geographic Access to Health Services. *Health Services and Outcomes Research Methodology 2000, 1(2):173-184.*

Fryer, G.E., Drisko, J. and Krugman, R.D. (1999). Multi-method assessment of access to primary medical care in rural Colorado. *Journal Rural Health, 15(1):113-121.*

Gesler, W.M. and Meade, M.S. (1988). Locational and population factors in Healthcare seeking behavior in Savannah, *Georgia. Health Serv Res, 23(3):443-462.*

Goodman, D.C., Fisher, E., Stukel, T.A. and Chang, C. (1997). The distance to community medical care and the likelihood of hospitalization: Is closer always better? *American Journal Public Health, 87:1144-50.*

Guagliardo, M.F., Ronzio, C.R., Cheung, I., Chacko, E. and Joseph, J.G. (2004). Physician accessibility: An urban case study of pediatric primary care. Health and Place, in press.

Gulliford, M.C. (2002). Availability of Primary Care Doctors and population-Health in England: Is There an Association? *Journal Public Health Med 2002, 24(4):252-254.*

Guptill, S.C. (1975). The Spatial Availability of Physicians. *Proceedings of the Association of American Geographers 1975, 7:80-84.*

Hansen, W.G. (1959). How accessibility shapes land use. *Journal American Inst Plannl 959, 25:73-76.*

Joseph, A.E. and Bantock, P.R. (1982). Measuring potential physical accessibility to general practitioners in rural areas: a method and case study. *Soc Sci Med, 16:85-90.*

Khan, A.A. and Bhardwaj, S.M. (1994). Access to health care. A conceptual frame work and its relevance to health care planning. *Eval health Prof, 17:60-76.*

Lee, R.C. (1991). Current approaches to shortage area designation. *Journal Rural Health, 7:437-50.*

Luo, W. (2004). Using a GIS-based floating catchment method to assess areas with shortage of physicians. *Health and Place 10(1):1-11.*

Luo, W. and Wang, F. (2003). Measures of spatial accessibility to healthcare in a GIS environment: Synthesis and a case study in Chicago region. Environment and Planning *Journal 30(6):865-884.*

Meden, T., St. John-Larkin, C., Hermes, D. and Sommerschield, S. (2002). Relationship between travel distance and utilization of breast cancer treatment in rural northern Michigan. *JAMA, **287(1)**:111.*

Nattinger, A.B., Kneusel, R.T., Hoffmann, R.G. and Gilligan, M.A. (2001). Relationship of distance from a radiography facility and initial breast cancer treatment. *J. Natl Cancer Inst, 93(17):1344-1346.*

Openshaw, S. (1984). The Modifiable Areal Unit Problem Norwick, Norfolk: Geo Books.

Parker, J.D. and Schoendorf, K.C. (2000). Variation in hospital discharges for ambulatory care-sensitive conditions among children. *Pediatrics, 06:942-8.*

Peng, Z. (1997). The jobs-housing balance and urban commuting. *Urban Studies, 34:1215-1235.*

Parchman, M.L and Culler, S.D. (1999). Preventable hospitalizations in primary-care shortage areas. An analysis of vulnerable Medicare beneficiaries. *Arch Fam Med, 8:487-91.*

Penchansky, R. and Thomas J.W. (1981). The Concept of Access. *Med care, 19(2):127-140.*

Reilly, W.J. (1931). The Law of Retail Gravitation. New York: Knickerbocker Press.

Salsberg, E.S., and Forte, G.J. (2000). Trends in the physician workforce, 1980–2000. *Health Aff (Millwood), 21:165-73.*

Schonfeld, H.K., Heston, J.F. and Falk, I.S. (1972). Numbers of physicians required for primary medical care. *N Engl Journal Med, 286:571-6.*

Shannon, G.W. (1984). Healthcare Delivery: Spatial Perspectives. New York: McGraw-Hill.

Shi, L., Starfield, B., Kennedy, B. and Kawachi, I. (1999). Income inequality, primary care, and health indicators. *Journal Fam Pract 1999, 48:275-84.*

Smedley, B.D., Stith, A.Y. and Nelson, A.R. (2002). Institute of Medicine (U.S.), Committee on Understanding and Eliminating Racial and Ethnic Disparities in Healthcare Unequal Treatment Confronting Racial and Ethnic Disparities in Healthcare Washington, D.C, National Academy Press.

Teicholz N; (2002) Uninsured patients in the District of Columbia Hospitals. *Health Aff (Millwood), 9(4):158-165.*

APPENDIX I

DEPARTMENT OF GEOGRAPHY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

SECTION A RESIDENTS IN GARKI

1 Name.

2 Sex

3 Residence

4 Occupation

Civil Servant Trader Farmer others

5 Nature of transportation network

Very good accessibility Good accessibility Poor accessibility Very poor accessibility

6 Distance covered before reaching nearest healthcare facility

0-1km 1-5km 5-10km 10km & above.

7 How long do you have to wait before seeing a doctor?

0 – 30mins 30 – 1hr 1hr – 2hrs Above 2hrs

SECTION B HEALTHCARE WORKERS ONLY

1 Name of Hospital

2 Total number of doctors in hospital

3 Total number of nurses

4 Number of bed spaces

5 Average number of patients / day

6 Average number of patients attended to by a doctor in 1 day.