SCHOOL OF PUBLIC HEALTH
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA

GEOSPATIAL ANALYSIS ON ACCESS TO MATERNAL HEALTH CARE IN JASIKAN DISTRICT

BY

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THIS HEALTH INFORMATICS PRACTICUM IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE IN HEALTH INFORMATICS

JULY, 2018
DECLARATION

I hereby declare that apart from referencing other peoples' work that I have duly acknowledged, this project is my original work produced from a research I have undertaken under the supervision and that no previous submission of either whole or part of this project has been made elsewhere for a degree. I, therefore, submit this project to the Department of Biostatistics, School of Public Health, University of Ghana in partial fulfillment of the award for Master of Science in Health Informatics.

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DATE ........................................
ACKNOWLEDGMENT

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<tr>
<td>2SFCA</td>
<td>2 Step Floating Catchment Area Analysis</td>
</tr>
<tr>
<td>ANC</td>
<td>Antenatal Care</td>
</tr>
<tr>
<td>CHPS</td>
<td>Community-Based Health Planning And Services</td>
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<tr>
<td>ESRI</td>
<td>Environmental Systems Research Institute</td>
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<tr>
<td>FANC</td>
<td>Focused Antenatal Care</td>
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<tr>
<td>GHS</td>
<td>Ghana Health Service</td>
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<tr>
<td>GIS</td>
<td>Geographical Information System</td>
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<tr>
<td>LMICs</td>
<td>Lower Middle-Income Countries</td>
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<tr>
<td>NHIS</td>
<td>National Health Insurance Scheme</td>
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<tr>
<td>PPME</td>
<td>Policy Planning Monitoring And Evaluation</td>
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<td>SD</td>
<td>Skilled Delivery</td>
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<td>UNDP</td>
<td>United Nation Development Program</td>
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<td>World Health Organization</td>
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ABSTRACT

Provision of maternal health care to pregnant women is to ensure the safety and good health of the mother and baby, but one of the challenges impeding maternal health care is accessible to the service. Access to Maternal health care is affected by where health professionals are located (supply) and where the target population resides (demand). Distance remains one of the key determinants in accessing maternal health care in rural areas due to the sparse location of settlement communities. Fatalities such as maternal mortality, neonatal mortality, stillbirth and infant mortality are higher in developing countries than in developed countries due to miss-match between antenatal attendance and the target population. One of the underlining factors to low antenatal and skilled delivery is lack of equitable distribution of resources to target populations. For effective resource allocation such as health facilities and human resource, there should be an efficient way to know where these resources should be placed to maximize utilization by enhancing proximity.

The application of geographical information system is to determine the "where" factor for decision and policy formulation with respect to a geographical area. 2step floating catchment area analysis was used concurrently with multiple ring buffer analysis to determine access to maternal health services.

The Thematic maps results visualize the geographical distribution pattern of health facilities providing ANC and skilled delivery and their proximity from the settlement communities in Jasikan District. 10 out of 33 communities fall beyond a 5 kilometer buffer radius to access antenatal and delivery services.
CHAPTER ONE

1.1 BACKGROUND

Maternal health care is one of the most prominent health challenges in the developing countries, according to the World Health Organization (WHO, 2010), over 300 million women in countries with developing economies experience significant maternal morbidity, and 99% of maternal deaths occur in developing countries (WHO, 2010).

The United Nations Development Program (UNDP) on Sustainable Development Goals stipulates that the proportion of pregnant women that do not survive childbirth in developing regions compared to those who survive in the developed regions is still 14 times higher, only half of the pregnant women in developing regions receive the recommended health care needed (WHO, 2016).

It has been widely acknowledged that one of the major factors contributing to the high rate of adverse birth outcomes is the low utilization and access to prenatal and maternal health services (Asundep et al., 2013). Hence the recognition that, antenatal care remains one of the safe maternity interventions which if well implemented has the potential to significantly reduce maternal and perinatal mortalities. The period of becoming pregnant to the time of delivery presents an opportunity for interventions to maximize maternal and newborn care. Regular antenatal (ANC) visits enable health caregivers to observe and manage pregnancy-related health problems on time to avoid complications. Some services provided during the antenatal period include treatment of pregnancy-induced hypertension, tetanus immunization, prophylaxis and micronutrient supplementation to pregnant women. Its effective implementation improves pregnancy and neonatal outcomes (Pediatric Perinatal Epidemiology, 15 Suppl., 2001).
Global estimates indicate that 225,000 women die in relation to childbirth, 904,000 neonatal deaths, and 1.02 million stillbirths occur annually (Lawn et al., 2009). Most of these deaths could be curtailed if all women give birth at the health facility where skilled attendants can provide emergency obstetric care and life-saving neonatal care when complications arise. Nonetheless, annual estimates indicate, 50 million women deliver at home without any skilled attendant (UNICEF, 2008).

Understanding the barriers that women face in the health care system is the surest way to improve maternal health care to reduce mortality and morbidity. This will identify priority areas for effective interventions. Although a number of studies have been conducted to examine barriers to accessing and utilizing maternal health care in Ghana, most of these studies have relied on quantitative analysis using data from the demographic and health surveys with little application of Geographic Information Systems (GIS) to evaluate physical barriers. This study is designed to look beyond the percentages and proportions to gain an in-depth understanding of the use of thematic maps to evaluate the barriers associated with access to maternal health care services.

Poor health infrastructure and scarcity of skilled birth attendants are major challenges in reducing maternal mortality (Ronsmans et al., 2015). International migration for improved conditions of service deprives developing nations of trained health professionals. In Ghana, Antwi and Phillips (2013) found that the migration of health workers decreased by one percent when they had a 10% increase in wages. This suggests health workers could be retained when better conditions are offered. Besides, midwives are not motivated to work in rural settings due to lack of opportunities, social amenities for their families, and reduced chances of career progression should they find themselves in areas where they...
could not easily access resources for continuous professional development (Lori et al., 2012).

The mismatch between ANC targets and attendance in sub-Saharan Africa has been recognized in many studies, and in response, to exploring this gap, social science researches that were conducted have relied on questionnaire surveys to collect data on variables that influence ANC attendance. These studies have correlated a variety of factors with antenatal attendance, examples are, the educational level of the woman and her husband, a woman’s occupation, parity, economic status, and age. Such statistical associations has offered a little insight into the mechanism(s) through which such factors functions, neglecting where they happen in a geographical context, answers to this question may provide indigenous interventions to targeted areas for effective resource allocation.

There has been little application and direction in the use of geospatial methods for developing health system in Jasikan District of Ghana where the study was conducted. The application of GIS cannot be undermined in the epoch of growing populations in addressing the needs of maternal health clients and maximize the impact of effective resource allocation.

In Ghana, the national target for antenatal coverage 85% but Volta Region achieved 68.9% and Jasikan district achieved 59.6% far below the national target (Volta Region Health Services Annual Report., 2017).
The region achieved a skilled delivery rate of 45.7% and that for the Jasikan District is 38% according to the District Health Directorate. Jasikan District has 62% of deliveries conducted at home or places other than a trained health personal. The risk and complication associated with unskilled delivery can result to the death of the mother or the child. Data from the District Health Directorate and the Jasikan District Hospital shows that the district recorded 17 stillbirth, 3 neonatal death and 2 maternal deaths.

The factors influencing the use of skilled services at delivery include demographic, socioeconomic, and other characteristics of the mother and her family, as well as aspects of the service environment such as distance to the nearest health facility and quality of care. While many epidemiological studies have investigated individual and household factors, the context within which utilization occurs with regards to the role of the environment and provider-related factor has been largely neglected.

Improving maternal health is one of the eight-millennium development goals (MDGs). Under MDG, countries committed to reducing maternal mortality by three-quarters between 1990 and 2015. Since 1990, maternal deaths worldwide have dropped by 47% according to the world health organization.

Safe Motherhood Initiatives, a worldwide effort was launched by the World Health Organization in 1987 which aimed to reduce the number of deaths associated with pregnancy and childbirth. Appropriate antenatal care (ANC) is one of the pillars of this initiative.
Geospatial analysis and the application of GIS is a suitable tool for exploration and making a decision. To maximize health service coverage and access, it is important to assess whether the locations of health facilities are appropriately distributed throughout among a dispersed settlement population. “Access” to a service refers to the physical presence of a facility offering that service within a given distance or catchment area of its potential clients and the availability of the intended service. A facility’s accessibility refers to the "travel impedance" the distance or travel time between the client's location and the facility (Tanser, 2006). A person’s access to a specific health service depends on geographic factors such as distance from their home to the facility and their connection to the transportation network.

GIS makes use of two types of data (Spatial data and attribute data) which describes where and how the object under study relates. Spatial Geographic data are about the physical location, in this instance, the geographic locations of health facilities and the community they serve.

The decision about where to direct resources should be guided by a thorough analysis of available data to ensure that investments in health services are targeted effectively. Resources must be allocated carefully in order to maximize the health impact of the targeted population.

1.2 PROBLEM STATEMENT

The research seek out to identify and analyze the problem associated with access to antenatal care and skilled delivery services in Jasikan District using geographical information system. One of the challenges impeding maternal health delivery services is
the proximity of the health service delivery centers to the pregnant women in need of the service. Antenatal care is a key service provision for reducing maternal mortality, neonatal death, and perinatal deaths through enhanced skilled delivery. The application of geographical information system (GIS) is to explore physical barriers such as distance to the use of maternal health services and prioritize areas for action.

Regardless of the various strategies for achieving ‘Health for All’ in the 1980s, in 1990 more than 70% of Ghanaians still lived over 8 km from the nearest health care provider (Sulemana & Dinye, 2014). Governments have introduced Policies and strategies to bring health care closer to the populace, one such policy and strategy is the Community-based Health Planning and Services (CHPS) which was introduced in 1999 and the National Health Insurance Scheme (NHIS) in 2004 to help achieve health for all irrespective of the economic and geographical conditions of individuals but access to antenatal and skilled delivery services remains a challenge to most pregnant women in Jasikan District.

Gestation period among woman is a critical stage that needs utmost attention and critical care to protect the mother and the developing baby. Having access to health services tailored to the needs of expectant pregnant women have been a challenge due to the geographical location of these facilities and the community where these women reside.

The question one may ask is why are some pregnant women not utilizing the services of any ANC service provider? Why do some pregnant women utilize antenatal care services from Traditional Birth Attendants? Where do the women in Jasikan District deliver? It is empirical that if we get to know ‘where’ things happen it is easy to know why they happen. The available evidence suggests that there are antenatal care services in Jasikan
district of Ghana but to where these services are rendered and its accessibility has left a lot to be desired with low antenatal coverage and skilled delivery in the district.

1.3 RATIONALE FOR THE STUDY

There have been a lot of resources channeled to curb mortalities related to maternal and infant deaths but equitable distribution of these resources to address maternal health issues still remain a challenge and Jasikan District is no exception. Access to antenatal care and skilled delivery services is one of the challenges the district is confronted with due to lack of uniformity in service provision. To geographically identify the level of antenatal coverage for each community and assess geographical barriers such as distance is one of the impulsion factors for the study. Distances to the nearest health facility have been one of the factors undermining antenatal coverage, skilled delivery and response to emergency services. Low antenatal attendance and delay in seeking health care as a result of long distance, still remains a mirage in Jasikan district. The research seeks to use the geographical information system to analyze the relationship between the service providers the settlement community.

1.4 MAIN OBJECTIVE

To examine health facility distribution and provision of maternal health care service in Jasikan District.

1.5 SPECIFIC OBJECTIVES

1. To determine the spatial distribution of health facilities providing antenatal services in Jasikan District.
2. To determine the spatial distribution of health facilities providing skilled delivery services in Jasikan District.

3. To examine the physical accessibility of maternal health services and access to service provision in skilled delivery at health facilities in the Jasikan District.
CHAPTER TWO

LITERATURE REVIEW

2.1 MATERNAL HEALTH CARE

Every year, more than 500,000 maternal deaths occur worldwide, 4 million newborns die and another 3 million babies are stillborn. Majority of these deaths occur in low and middle-income countries and most of these deaths could be avoided with existing medical care (Gabrysch, Cousens, Cox, & Campbell, 2011).

Most maternal health complications occur around the time of delivery making it difficult to predict. Pregnant women need to have access to a skilled attendant due to uncertainties during delivery. A skilled attendant is equipped with skills in midwifery and she is able to conduct a normal delivery and can identify and manage maternal health complications or give a timely referral if needed. Having access to a skilled attendant at delivery is advocated as the single most important factor in preventing maternal mortalities (WHO/UNICEF/World Bank. Geneva, 1999) and the proportion of births attended by skilled health personnel was one of the indicators for Millennium Development Goal five. Stillbirth and newborn survival could be enhanced when pregnant women attend to skilled health personnel for delivery services. Deliveries by a skilled attendant can be performed either at homes, in health centers or in hospitals, but it is argued that the most effective strategy for lower-income countries is to provide skilled attendant in health centers with the capacity to refer. In practice, skilled attendance in most countries is synonymous with facility delivery.
Studies on determinants of skilled attendance at delivery have explored a plethora of potentially significant factors. In a review article "Too far to walk" Thaddeus and Maine summarized these factors under their conceptual framework of the three delays, socio-cultural and financial accessibility variables, perceived benefit and physical accessibility.

2.2 ANTENATAL CARE

Antenatal care (ANC) can be defined as the care provided by skilled health care professionals to pregnant women and adolescent girls in order to ensure the best health conditions for both mother and baby during pregnancy (WHO, 2016). Some of the components of antenatal care include identification of pregnant women who are at risk of maternal complications, prevention, and management of pregnancy-related or concurrent diseases, education on maternal health and newborn care. Integrated service delivery provides an opportunity to manage and prevent concurrent diseases. The introduction of Focused ANC (FANC) model in low and middle-income countries (LMICs) in 2002 by the World Health Organization is a goal orientated approach to delivering evidence-based interventions carried out at four critical times during pregnancy (WHO, 2006). However, global statistics indicate that, during the period 2007 to 2014, only 64% of pregnant women attended the recommended minimum of four antenatal visits by the WHO, this is an indication that much more works needs to be done to address ANC utilization. (WHO, 2016)

According to (Dickson, Kofuor, Darteh, & Kyereme, 2017) the national coverage for antenatal services in Ghana for the recommended four or more ANC visits is above the global average of 64% but there is much difference in urban and rural maternal health coverage as well as regional discrepancies among maternal health service providers and
pregnant women with regards to accessing skilled care (Abor, Abekah-nkrumah, Sakyi, Adjasi, & Abor, 2000) Irrespective of the socioeconomic and demographic factors, pregnant women registered in the National Health Insurance Scheme (NHIS) make more antenatal visit compared with those who are not registered. Educated women who reside in urban centers are more likely to attend antenatal care visits than women who are uneducated in rural areas who are from poorer households (Dickson et al., 2017).

The World Health Organization (WHO) envisages a world where every woman in her gestational period and newborns will receive quality care during pregnancy, childbirth and the postnatal period (WHO, BJOG, Declaration, 2015) However, in 2015, about 303,000 women and adolescent girls died as a result of complication related to pregnancy and childbirth. Approximately, 99% of maternal mortality occurs in low-resource regions and most of these mortalities can be prevented (WHO, 2014). Similarly, an estimated 2.6 million babies were stillborn in 2015, mainly in regions with low resources. However, there is an indication that effective interventions are available at a realistic cost for the treatment or prevention of almost all life-threatening maternal health complications (WHO, 2016), (Ayanore, Pavlova, & Groot, 2016)

### 2.3 SKILLED DELIVERY

WHO defines a skilled attendant as qualified health professional who has been trained and with the expertise to identify, provide and manage normal pregnancies and refer pregnant women and newborns during difficulties. These persons include doctors, midwife or nurses (WHO, 2002). In Ghana, majority of ANC providers are midwives, who advise pregnant women on how to safely maintain their pregnancy and deliver safely. It also presents health workers the opportunity to detect and prevent possible danger early and
take appropriate action. Despite the numerous benefits derived from skilled delivery and its tendency in helping to decrease maternal death, skilled care during delivery has been underutilized even when made available (Dickson et al., 2017).

Poor accessibility to skilled delivery services has been recognized as the main setback in sub-Saharan Africa to maternal and newborn health (Ganle, Fitzpatrick, Otupiri, & Parker, 2016). The density of service providers can affect maternal death rates (WHO, 2016). The difference in skilled health personnel and supportive infrastructure for maternal health care is estimated to be large hence the need to for equitable distribution of these resources to close the gap. According to the 2005 World Health Report, it is projected that approximately 700,000 professionals are required to fully protect all women during delivery by 2030, that is 330,000 to increase the number of personnel and 370,000 to make up for attrition. To achieve 73% coverage by 2015, 334,000 more health-care professionals were employed. To maximize skilled delivery coverage, skilled professionals need to be supported with, 24,000 birthing units, 27,000 doctors and technicians, and 11,000 maternity units within facilities (Koblinsky et al., 2015). These estimates, based on new WHO benchmarks of the facilities and human resources that are needed to cover births with essential first level and back-up care in 75 countries, 5 underscore the need to document the supply and geographic distribution of professional skilled care providers and their required supportive infrastructure (Koblinsky et al., 2015).

One of the utmost needs to improve access to skilled care at delivery is through health centers as recognized by AbouZahr C, (2011). Reducing the financial burden on families who seek skilled attendance is one approach to enhance the utilization of service by removing user fees. Countries like Ghana have adopted free maternal health policy to
remove the financial barrier in accessing care. Geographical access to a health facility is the major hurdle that needs to be resolved in order to give credence to other determinants in accessing health care. Geographical access to providing maternal health services forms a vital component of health system assessment and strategic planning.

Gething et al, (2012) by reviewing 322 maternal mortalities occurring in health facilities in Ghana in 2011, established delay in arrival at a health facility to be a contributing factor in approximately 46% of cases. Distance is strongly implicated in many of the delays rather than decision making at home.

Assessing geographical accessibility over large regions is challenging due to data requirements in developing countries. Complete data that encompasses the entire geographical distribution variable is required of both the population and the health facilities to which mothers must travel to access care. Such data sets require a level of spatial detail and completeness.

2.4 GEOSPATIAL ANALYSIS AND DISTANCE

According to Goodchild (2000), (Goodchild, n.d.) GIS was described as a computing application that allows the user to create, store, manipulate, visualize and analyze geographic information. GIS is most useful in fields such as resources allocation, utility management, telecommunications, regional planning, monitoring and evaluating health care outcomes, vehicle routing as well as all the sciences which deals with the surface of the earth. The acronym GIS has been defined by the Environmental Systems Research Institute (ESRI) as a Geographic Information System. GIS is seen as an integrated
collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes.

GIS has a central database which facilitates the exploration, organization, projecting and visualizing spatial data. Geographic data includes a set of single geo-referenced features or point locations to a more complex collection of data structured in a database (Goodchild, 2007). According to Zlatanova et al (2002), GIS has five basic functions which comprise of data structuring, data capture, data manipulation, data analysis and data presentation.

GIS can be used to explore data that exist in a natural state that helps with answers to questions and problem solving such as access to a geographical location. The geographical information system has three dimensions, the database, the map and the model.

GIS enables the creation of maps that presents a set of intelligent illustrations which can describes relations on the earth surface and gives a descriptive overview of distribution patterns. GIS enables the application of tools that allow users to convert information into newly transformed datasets from an existing dataset. GIS application of logical functions enables the outline of results. (Dumitrescu, Smeureanu, 2010).

Geographic variation in population, and population need for health care, provides the foundation for analysis and planning of health services. People are not spread evenly across the Earth’s surface, and populations differ along many dimensions including age, gender, culture, and economic status that affect their need for health care, their ability to travel to obtain health care, and the types of services they are willing and able to utilize. Increasingly, GIS is being used to map and explore geographical variation in need for health services and to develop innovative indicators of health care need.
The geography of health care comprises the analysis of spatial organization (number sizes, types, and locations) of health services, how and why spatial organization changes over time, how people gain access to health services, and the impacts on health and well-being (McLafferty, 2003).

Improving maternal health is globally introduced as an important health priority. It is therefore important to identify the high priority areas which require more maternal health services in Jasikan District. The application of GIS provides us with the capability to identify high priority areas which need maternal care and the accessibility of the service. Increase in population will probable increase in the fertility rate, it is wise to plan proper schedules to improve health care services for pregnant women in Jasikan District.

The use of GIS in maternal health will focus on potential geographic access to care on the basis of the spatial distribution of health facilities. GIS application will help investigate the impact of geographic access on antenatal and delivery care services as well as availability and accessibility coverage in the district.

An effective health care system is the one with a powerful monitoring system which considers the needs of the vulnerable groups and identifies any progress or problem in the system immediately. One of the latest technologies which can be used to promote better health care, health policy and decision-making is GIS (Geographical Information System) which is a computerized system to collect, keep, analyze and display geographic information. GIS is a useful tool which identifies regional disparities in order to employ more educated individuals and to exert more health facilities (Salihe, Ahmadian, 2017).
CHAPTER THREE

METHODOLOGY

3.1 STUDY AREA

Jasikan District was established in 1989 by a Legislative Instrument (LI1464). The Biakoye District was carved from the original Jasikan District in 2004 and has therefore been reduced in size. Jasikan District is located in the northern part of the Volta Region. It shares a boundary with the Kadjebi District to the north, the Biakoye District in the West, the Hohoe Municipality in the South and the East with the Republic of Togo. The district covers a total land area of 555.8 square kilometers representing 6.6 percent of the entire land area of the Volta Region. Jasikan the District capital, lies 110 kilometers north-east of Ho, the regional capital.

Figure 3.1: Study area showing the distribution of communities (Jasikan District)
3.2 STUDY DESIGN

This study was a descriptive cross-sectional study that adopted spatial methods in quantifying the accessibility of maternal health services to communities in the Jasikan District.

The study retrospectively describes and conducts spatial statistical analysis on the key determinant of low antenatal coverage and skilled delivery based on spatial and attribute data collected on the communities under study. The study describes the geographical patterns of the variables under study.

3.3 DATA SOURCE

3.3.1 ROUTINE HEALTH MANAGEMENT INFORMATION SYSTEM DATA

Data was from the DHIMS 2 database of the Jasikan District Health Directorate. Data on antenatal care and deliveries were routinely collected and aggregated into the DHIMS 2 software. The data analyzed was collected between January and December 2017.

To estimate the staff to population ratio of maternal health service delivery in Jasikan District, data on the number of midwives in each health facility was sought from the human resource office of the District Health Administration. The maximum number of midwives that served in a health facility within 2017 was used as the staff strength for skilled delivery services.

Demographic data on estimated pregnancies was sourced from the District Health Administration and the District Assembly; this was used as the estimate for demand for skilled delivery services in all analysis.
3.3.2 SPATIAL DATA
Location of health facilities and communities were also available from the district health administration but were not complete. Hence, a GPS handheld device was used to collect coordinates from the central point of communities and health facilities. These coordinates were collected with a maximum of three meters accuracy to reduce the propagation of error. Also, the existing coordinates from the District Health Administration were validated using Google Earth imagery to ascertain if they fell at their true locations.

3.3.3 ATTRIBUTE DATASET
This comprises the following;

The number of skilled delivery conducted by the health facility

The number of women registering and attending antenatal care

The name and population of communities’ within the study area

The type and services provided by the health facilities

3.3.4 SPATIAL DATASET
This includes the following;

Coordinates of health facilities

Digitalized base map of Jasikan District

The boundaries of the area under study
3.4 DATA ANALYSIS

3.4.1 POINT ON POLYGON OVERLAY ANALYSIS

Overlay analysis is one of the most dominant tools in the application of GIS because of its ability to join several map layers. This feature becomes more applicable when multiple geographic data are stored in a common coordinate system enabling the viewing of map layers simultaneously. This permits users to make an informed decision on spatial relationships among features of different layers (Vine, Degnan, & Hanchette, 1997). One of the maps this study applied was a composite map of three overlays. These three overlays comprise, Point layer of health facilities, point layer of community centroid and a polygon layer of Jasikan District.

3.4.2 MULTIPLE RING BUFFERS AND SPATIAL JOIN

The below or above 5km distance categorization was adopted for this study based on observations from a systematic review where various studies in sub-Saharan Africa including Ghana used this classification as an ideal measure of accessibility (Wong, Benova, & Campbell, 2017).

Multiple ring buffers were created around health facilities providing skilled delivery and ANC services. The distance specified for the buffers ranged from one to five kilometers with increments of one. This was used to assess the proximity of these services at the various distances. To extract descriptive statistics from this analysis, a spatial join was performed to join the communities in the buffers. This resulted in a layer that had the expected pregnancies and proximity to the service provided.
3.4.3 DISTANCE TO COMPREHENSIVE OBSTETRIC SERVICES
The distance to the district hospital which serves as only health facility with the requisite resources to provide a comprehensive maternal and newborn service was calculated for each community. The point distance tool in ArcGIS was used to generate the Euclidean distance from each community to the hospital. The results were presented on a graduated symbol map that showed the relative distances.

3.4.4 PIVOT TABLE ANALYSIS
The results of the spatial join were exported to Microsoft Excel to calculate some basic descriptive statistics. The count and proportion of communities; and the sum of estimated pregnancy and their proportion were calculated for each buffer distance band. This analysis was done for both ANC and skilled deliveries.

3.4.5 THE TWO STEP FLOATING CATCHMENT AREA (2SFCA)
The 2SFCA is a model used to measure the spatial accessibility of services. It uses the demand for services and the provision of services to create an index of spatial accessibility of services. The 2SFCA model was first applied to health (Luo & Wang, 2003). This first application of 2SFCA quantified the spatial accessibility to primary care in Chicago, USA. The 2SFCA combines two models in GIS that is the gravity model which assesses utilization as a function of distance decay and the floating catchment method that assesses service provision within a threshold and demand.

There have been several modifications of the 2SFCA model (Delamater, 2013; Luo & Whippo, 2012; McGrail, 2012; McGrail & Humphreys, 2009; Ngui & Apparicio, 2011). Different researchers have attempted to improve the efficiency of this model by altering
some of its parameters. For instance, McGrail (2012) suggests that variable window sizes should be used for the 2SFCA and distance decay functions should be incorporated. This recommendation was implemented in Illinois to quantify the physician to population ratio (Luo & Whippo, 2012). Another study has weighted both the demand and provision variables and used network distance (Ngui & Apparicio, 2011).

The data for the model in this study consisted of two layers; the health facilities providing skilled delivery service with the emphasis on the number of midwives; and a layer of the communities with emphasis on skilled delivery services expressed as the expected pregnancies.

### 3.4.5.1 STEP 1 OF 2SFCA

The first step of the 2SFCA involves a spatial join of the service provision and demand layer. The communities were joined to the health facilities to determine the communities that fell within five kilometers of skilled delivery provision. The join type was a one to one join to preserve unique skilled delivery locations for the resultant layer. Also, a field in the attribute table then contains the number of communities within five km of each skilled delivery provision.

\[
R_j = \frac{HC_j}{\sum_{k \in \{d_{kj} \leq d_0\}} P_k}
\]

\textit{equation 1}

\[
A_i^F = \sum_{j \in \{d_{ij} \leq d_0\}} R_j
\]

\textit{equation 2}
\( R_j = \text{Midwives to population ratio at the health center with a catchment of threshold}(d_{ij} \leq d_0) \)

\( HC_j = \text{Number of midwives at location j} \)

\( d_{kj} = \text{distance between k and j (travel distance)} \)

\( A^F_i = \text{The accessibility 2SFCA index} \)

\( d_{ij} = \text{distance between i and j (travel distance)} \)

Subsequently, a ratio of the skilled delivery provision to demand is calculated from the result by dividing the distance (5km) by the count of communities in that distance multiplied by the expected pregnancies. Equation (1) details the calculation of the first step where the estimated pregnancy \( (P_k) \) distance threshold \( (d_{kj}) \) and the number of midwives \( (HC_j) \) are used in computing the first stage of the model.

### 3.4.5.2 STEP 2 OF 2SFCA

The main focus of the second step is to find the sum of provision within the catchment of each community. Hence, in the second step, the result from step 1 is joined to the community’s layer and the ratio of skilled delivery to demand is summed up for each community to arrive at a final index of skilled delivery accessibility. The same 5km distance threshold is applied to sum up the demand-provision ratios. The result is presented using a graduated color thematic map that highlights the distribution of skilled delivery across the district. Equation (2) shows the second stage where the provision is summed for each community within a defined catchment.

Data was analyzed using ArcGIS 10.4 and Microsoft Excel.
CHAPTER FOUR

RESULT

4.1 DEMOGRAPHIC CHARACTERISTICS

Summary statistics on secondary data collected shows a total of 22 health facilities providing health service in Jasikan District. 12 of the health facilities provide antenatal services and 9 of the facilities provide delivery services. A total of 1663 women were registered for antenatal care and total antenatal visits were 7607. Antenatal coverage for the district was 59% and percentage skilled delivery was 37.7%.

Table 4.1 shows antenatal coverage for each health facility and the population eligible for antenatal services in Jasikan District. ANC coverage for Jasikan District Hospital and New Ayoma Health Center was 599% and 195% respectively, exceeded their target population eligible for ANC services. Okadjakrom CHPS recorded the least coverage of 15%.

Table 4.1: Antenatal Coverage

<table>
<thead>
<tr>
<th>HEALTH FACILITIES</th>
<th>ANC REGISTRATION</th>
<th>ANC ATTENDANCE</th>
<th>POPULATION</th>
<th>POPULATION OF ELIGIBLE FOR ANC</th>
<th>ANC COVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kute Health Centre</td>
<td>128</td>
<td>596</td>
<td>6125</td>
<td>245</td>
<td>52%</td>
</tr>
<tr>
<td>Baika Health Centre</td>
<td>45</td>
<td>113</td>
<td>3100</td>
<td>124</td>
<td>36%</td>
</tr>
<tr>
<td>New Ayoma Health Centre</td>
<td>330</td>
<td>1280</td>
<td>9625</td>
<td>385</td>
<td>86%</td>
</tr>
<tr>
<td>Old Ayoma Health Centre</td>
<td>19</td>
<td>43</td>
<td>2000</td>
<td>80</td>
<td>24%</td>
</tr>
<tr>
<td>Bodada Health Centre</td>
<td>144</td>
<td>458</td>
<td>8800</td>
<td>312</td>
<td>46%</td>
</tr>
<tr>
<td>Jasikan District Hospital</td>
<td>802</td>
<td>4653</td>
<td>21658</td>
<td>906</td>
<td>88%</td>
</tr>
<tr>
<td>Okadjakrom CHPS</td>
<td>18</td>
<td>28</td>
<td>3000</td>
<td>120</td>
<td>15%</td>
</tr>
<tr>
<td>Akaa CHPS</td>
<td>48</td>
<td>98</td>
<td>4125</td>
<td>165</td>
<td>29%</td>
</tr>
<tr>
<td>Nsuta Buem Health Centre</td>
<td>71</td>
<td>212</td>
<td>5750</td>
<td>230</td>
<td>31%</td>
</tr>
<tr>
<td>Samanhyia CHPS</td>
<td>48</td>
<td>101</td>
<td>5255</td>
<td>210</td>
<td>23%</td>
</tr>
<tr>
<td>Attakrom CHPS</td>
<td>8</td>
<td>17</td>
<td>1095</td>
<td>44</td>
<td>18%</td>
</tr>
<tr>
<td>Kabisayor CHPS</td>
<td>2</td>
<td>8</td>
<td>380</td>
<td>15</td>
<td>13%</td>
</tr>
</tbody>
</table>

Source: Jasikan DHD, 2017
Table 4.2 shows delivery coverage among health facilities conducting delivery. Jasikan District Hospital exceeded its delivery target by 448%, the highest gap between expected delivery and skilled delivery conducted was at Samanhyia CHPS.

Table 4.2: Skilled Delivery

<table>
<thead>
<tr>
<th>HEALTH FACILITY</th>
<th>POPULATION</th>
<th>EXPECTED DELIVERY</th>
<th>SKILLED DELIVERY</th>
<th>PERCENTAGE DELIVERY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kute Health Centre</td>
<td>6125</td>
<td>245</td>
<td>73</td>
<td>30%</td>
</tr>
<tr>
<td>Baika Health Centre</td>
<td>3100</td>
<td>124</td>
<td>4</td>
<td>3%</td>
</tr>
<tr>
<td>New Ayoma Health Centre</td>
<td>4225</td>
<td>169</td>
<td>139</td>
<td>82%</td>
</tr>
<tr>
<td>Bodada Health Centre</td>
<td>10800</td>
<td>312</td>
<td>73</td>
<td>23%</td>
</tr>
<tr>
<td>Jasikan District Hospital</td>
<td>3350</td>
<td>906</td>
<td>734</td>
<td>81%</td>
</tr>
<tr>
<td>Okadjakrom CHPS</td>
<td>3000</td>
<td>120</td>
<td>3</td>
<td>3%</td>
</tr>
<tr>
<td>Akaa CHPS</td>
<td>4126</td>
<td>165</td>
<td>7</td>
<td>4%</td>
</tr>
<tr>
<td>Nsuta Buem Health Centre</td>
<td>5750</td>
<td>230</td>
<td>25</td>
<td>11%</td>
</tr>
<tr>
<td>Samanhyia CHPS</td>
<td>7500</td>
<td>300</td>
<td>3</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: Jasikan DHD, 2017
4.1.1 PATTERN OF HEALTH FACILITIES AND COMMUNITIES.

Figure 4.1: Distribution Patterns of the Health Facility Type and Communities in Jasikan District

Figure 4.1 shows the distribution pattern of health facilities and communities in the district. An overlay analysis of the layers helps in easy identification of the type of health facilities and the communities in Jasikan District. Results show that some communities are distances away from a health facility whiles other communities are closer. The health facilities have been segregated using a color code to depict CHPS, health centers, clinic and a hospital. The map shows that majority of the CHPS facilities are at the northern part of the district with two health centers. The southern part of the map shows the presence of more health centers than CHPS. The map shows one hospital located along the main road close to the border of the district. The map also shows that majority of the communities
are located at the northern part close to the Kadjebi District. The district has one clinic located close to the only hospital.

4.2. SPATIAL DISTRIBUTION OF HEALTH FACILITIES PROVIDING ANTENATAL CARE

Figure 4.2: Distribution of health facilities providing ANC services and facilities that do not provide ANC

Figure 4.2 shows the results of the spatial distribution of health facilities providing antenatal services in the district. The spatial overlay analysis distinguishes facilities that provide ANC and facilities that do not provide ANC services. Observations show that the majority of facilities offering ANC services are at the northern part of the district. All the health centers located at the southern part of the district offer antenatal services. There are
some communities at the western end of the district and along the border of Togo at the western part of the district that do not have facilities providing antenatal care.

4.3 SPATIAL DISTRIBUTION OF HEALTH FACILITIES PROVIDING DELIVERY SERVICE

Figure 4.3 shows the results of spatial overlay analysis depicting the distribution of health facilities in Jasikan District that provide delivery services and facilities that do not provide delivery services. The pattern follows the similar distribution of health facilities providing ANC but has a lesser number of health facilities. The delivery facilities are not evenly spread across the district and indication that facilities are set up in settlement communities.
4.4 ACCESS TO MATERNAL HEALTH SERVICES

4.4.1 PHYSICAL ACCESSIBILITY TO HEALTH FACILITIES PROVIDING ANTENATAL CARE

Figure 4.4 shows the results of the spatial distribution of health facilities offering ANC services and a multiple ring buffer that highlights the proximity of communities to ANC services. Results of the multiple ring buffer overlayed with communities show most of the health facilities providing ANC service are in the Northern part of the district along the Jasikan to Kadjebi stretch of the Eastern Corridor road. In total, there were 12 health facilities providing ANC service out of 22 health facilities.
Table 4.3 shows further exploration of the multiple ring buffers via a spatial join with communities. Eleven communities were beyond five kilometers resulting in 18.48% of total expected deliveries falling outside the 5 km buffer. In contrast, 21.68% of communities with an associated 36.87% expected deliveries were within one-kilometer reach of a health facility providing ANC services. 12% of communities fall within one to two kilometers radius from a facility with an expected pregnancy of 34.29 percent. Two communities were within two to three kilometer radius with an expected pregnancy of 4.61%. A percentage of 10.59 and 8.57 of communities fall within 3-4 and 4-5 kilometers radius with expected pregnancies of 2.55% and 3.20% respectively.

<table>
<thead>
<tr>
<th>Distance to the community (Km)</th>
<th>Number of communities</th>
<th>Percent</th>
<th>Total expected pregnancy</th>
<th>Percent expected pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>9</td>
<td>21.68%</td>
<td>1045.84</td>
<td>36.87%</td>
</tr>
<tr>
<td>1-2</td>
<td>6</td>
<td>12.77%</td>
<td>972.76</td>
<td>34.29%</td>
</tr>
<tr>
<td>2-3</td>
<td>2</td>
<td>7.23%</td>
<td>130.84</td>
<td>4.61%</td>
</tr>
<tr>
<td>3-4</td>
<td>3</td>
<td>10.59%</td>
<td>72.4</td>
<td>2.55%</td>
</tr>
<tr>
<td>4-5</td>
<td>3</td>
<td>8.57%</td>
<td>90.64</td>
<td>3.20%</td>
</tr>
<tr>
<td>Greater than 5</td>
<td>11</td>
<td>39.16%</td>
<td>524.08</td>
<td>18.48%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>34</td>
<td>100.00%</td>
<td>2836.56</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
4.4.2 PHYSICAL ACCESSIBILITY TO HEALTH FACILITIES PROVIDING DELIVERY SERVICES

Similar to the ANC buffer, Figure 4.5 shows the proximity to health facilities providing skilled delivery services. There were nine health facilities providing skilled delivery services with a distribution pattern similar to ANC. Most of these facilities were along the major road leading to Kadjebi. Communities along the Eastern part of the district were most the marginalized.

Table 4.4 further explores the relationship between the health facilities providing skilled delivery service and proximity through a spatial join. Results revealed almost half of the communities (43.19%) were outside the five km buffer. These communities hold almost
one third (27.47%) of the total expected deliveries within the district. However, 30.17% of skilled deliveries were within one kilometer of a skilled delivery health facility. Within one to two kilometer radius, 9 percent of communities are located with an expected pregnancy of 28.70%. One community was within 2-3 kilometer radius with an expected pregnancy of 2.14%. The percentage of communities within 3-4 kilometers radius was 15.80% with an expected pregnancy of 8.90%. Within 4-5 kilometers radius of a skilled delivery facility, the expected pregnancy was 2.61% with 9.08% of communities.

Table 4. 4: Summary statistics for the spatial join of distance buffer and expected pregnancy for health facilities conducting delivery services

<table>
<thead>
<tr>
<th>Distance to the community (Km)</th>
<th>Number of communities</th>
<th>Percent Communities</th>
<th>Total expected pregnancy</th>
<th>Expected pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>7</td>
<td>17.65</td>
<td>855.84</td>
<td>30.17</td>
</tr>
<tr>
<td>1-2</td>
<td>4</td>
<td>9.75</td>
<td>814.12</td>
<td>28.70</td>
</tr>
<tr>
<td>2-3</td>
<td>1</td>
<td>4.54</td>
<td>60.84</td>
<td>2.14</td>
</tr>
<tr>
<td>3-4</td>
<td>5</td>
<td>15.80</td>
<td>252.4</td>
<td>8.90</td>
</tr>
<tr>
<td>4-5</td>
<td>3</td>
<td>9.08</td>
<td>74.12</td>
<td>2.61</td>
</tr>
<tr>
<td>Greater than 5</td>
<td>14</td>
<td>43.19</td>
<td>779.24</td>
<td>27.47</td>
</tr>
<tr>
<td>Grand Total</td>
<td>34</td>
<td>100.00</td>
<td>2836.56</td>
<td>100.00</td>
</tr>
</tbody>
</table>
4.4.3 ACCESS TO SERVICES PROVISION (SKILLED DELIVERY)

As the multiple ring buffers measured physical accessibility in terms of proximity, the 2SFCA analysis focused on the ratio of the provision to demand within the same five km buffers. The results showed ten communities did not have provision at all within the defined distance radius. Communities in the South Eastern part were less populated but had enough midwives to man health facilities hence they had the best ratio.

![Figure 4.6: 2SFCA results showing the index of skilled delivery provision using the number of midwives and expected pregnancy](image)

Figure 4.6 is a box plot that shows the distribution of the 2SFCA index. It shows a high number of communities that were having no provision for skilled delivery services and a mean 0.05 index. The demand-provision index ranged from 0 to 0.03. Baglo, Dzolu and
Dzoku communities who were served by health facilities in Baglo, New Ayoma and Kute had the highest index.

Figure 4.7: Boxplot showing the distribution of 2SFCA index
4.5 DISTANCES TO JASIKAN DISTRICT HOSPITAL FOR SECONDARY CARE

Euclidean spatial analysis on distance was used to determine the distance a client will travel from a community to access health care at the Jasikan District Hospital. A graduated color was used to ascertain the minimum distance to the maximum distance. The maximum distance to access secondary health care from a settlement community is 22.7km. The average distance is 11.4 km.

Figure 4.8: Euclidean distances from the community to Jasikan District Hospital
CHAPTER FIVE

DISCUSSIONS

5.1 DEMOGRAPHIC CHARACTERISTICS AND ACCESS TO MATERNAL HEALTH

Uneven distribution of the population in Jasikan District and the resources that facilitate health care has widened the gap between pregnant women who are able to access maternal health services and those who are not able to access maternal health care. The demographic statistics show that the expected number of pregnant women in each community differs and this does not have any relationship with the number of service providers in the district. It is, however, prudent to strategically balance the demand and supply of maternal health services to close the gap. Two health facilities exceeded their eligible target population which is an indication that women from other catchment area need to travel to other health facilities to access care.

5.2 PHYSICAL ACCESSIBILITY OF ANTENATAL SERVICES

The World Health Organization (WHO) recommends that women start antenatal care during the first trimester of pregnancy. This is to ensure at least four visits in order to identify complications early and manage them effectively (Were et al., 2013). However, results of the study show that most of the expectant mothers could not access antenatal care within the community they reside. An inhibiting factor due to the proximity of the communities to the health centers.

Distance has been realized as the main determinant in accessing health care due to the sparse distribution of communities and the health facilities that provide antenatal services.
The output on distance from 1 kilometer to 5 kilometer buffer from a point location which is the health facility indicates that some communities have a shorter distance to access antenatal services than other communities. Geo-visualization of the spatial distribution of the communities and the facilities providing antenatal services provide a graphical view of proximity to access antenatal care.

5.3 PHYSICAL ACCESSIBILITY TO DELIVERY SERVICES
A study conducted by Johnson et al., (2015) explored access to conventional health facilities in communities within 8 kilometers compared to communities beyond 8 kilometers shows a significant uptake in skilled birth within the stated buffer zone (Johnson, Frempong-aignuah, Matthews, & Andrew, 2015). From the results obtained from the multiple ring buffers, it was realized that few communities fall within 1 kilometer to 5 kilometer buffer around the delivery facilities and the majority of the communities fall outside the 5 kilometer buffer. Multiple ring buffer analysis gave a systematic graphical view of the communities and their proximity to access skilled delivery.

5.4 ACCESS AND UTILIZATION OF SERVICES (SKILLED DELIVERY)
Human resource is key to any service provision. The number of the skilled attendant for delivery services should be evenly distributed to meet the demand of the target population. This study looked at the number of midwives allocated to a health facility and the number of expected pregnancies within 5 kilometer radius equidistance from the health facility.

According to Gabrysch et al.,( 2011) proximity to health facilities conducting delivery has a positive relation with the number of facility or skilled delivery services conducted. This is same with the obstetric emergency which shows a higher association with the
availability of maternal health service. This was in line with results obtained in the two step floating catchment area analysis where service delivery had a high index within 5 kilometers of proximity to a health facility with respect to the number of midwives.

The 2 step floating catchment area analysis method was used to show access to delivery services. The index generated shows facilities with greater access and utilization relative to the expected pregnancies and within 5 kilometer and the number of midwives. Results show that access to service is not normally distributed across the district.

5.5 DISTANCES TO JASIKAN DISTRICT HOSPITAL

The Jasikan District Hospital is the most utilized health facility in the district. It exceeded its antenatal and skilled delivery coverage. The district hospital serves as a point for referrals from the primary health facilities for specialist care to pregnant women; distance remains a factor from each community to the Jasikan District Hospital to ensure prompt and utmost care. The maximum distance traveled using the Euclidian distance approach was 22.7 kilometers and an average of 11.4 kilometers. The graduated symbol analysis attributed the maximum distance to be from the New Baika community.

5.6 LIMITATIONS TO THE STUDY

Although this study provides credible evidence for planning and improving skilled delivery services, there were a few methodological issues that could be addressed in subsequent studies. Lack of data on home deliveries was a challenge in doing an in-depth analysis of children born at home. This is due to the absence of institutional measures not in place to capture home deliveries.
Given that there have been improvements to the 2SFCA model, this study could have used one of such advanced models but the data required was not available. For instance, Ngui & Apparicio (2011) used a network distance for their model instead of the less accurate Euclidean distance. Also, people also choose health facilities not necessarily by distance but their attractiveness. Such metrics which are used in gravity models cannot be implemented in 2SFCA models.
CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

Distance is one of the determinants in accessing maternal health care in Jasikan District. To mitigate the impact of low antenatal coverage and skilled delivery in the district, health facilities offering maternal health services should be equitably distributed based on distance from each community.

Equitable allocation of resources such as human resource will enhance availability of maternal health service and increase access at the various service delivery centers. This will bring a balance between the areas with high ANC and delivery coverage compared to areas with low coverage.

Health facilities which are more than 5 kilometers away from the district hospital which provides secondary services should expedite prompt actions during referral based on the distance to be covered this will enhance optimum utilization of available maternal health service.

Areas with low accessibility ratio indicate a need to increase the number of facilities offering the service of interest. Where high accessibility ratios overlap with low levels of utilization (high coverage gaps), it can suggest that physical accessibility may not be the main determinant of utilization and that other barriers might exist.
The population living outside a health facility’s catchment area can be thought of as lacking access to that facility’s services. Therefore, settlements that do not fall within the service catchment area or buffer of any facility might be potential sites for establishing new facilities.

Distribution of service among health facilities that are not currently offering the service of interest should be prioritized, resources may be better invested in those existing facilities so that they can offer those services, rather than investing in entirely new facilities.

6.2 RECOMMENDATION

Access to maternal health services such as antenatal and delivery services is vital in reducing maternal mortalities, neonatal mortalities, and infant mortalities. It is therefore empirical for the district to factor the distance pregnant women need to travel in the initial planning and siting of health facilities. The allocation of health care professional at the health facilities should be done equitably with regards to the location of the community and their population.
REFERENCES


