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SPATIAL ANALYSIS OF HEALTH CARE FACILITIES IN CALABAR METROPOLIS, CROSS RIVER STATE, NIGERIA

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Abstract

Varying terrain characteristics, politically motivated awkward distribution, poor road connectivity, and overpopulation tend to result in spatial inequality in the distribution and accessibility to Health care facilities (HCFs) in developing countries like Nigeria. Thus, this study analyzed the spatial distribution and accessibility to health care facilities in Calabar metropolis, Cross River State, Nigeria. For this purpose, data on HCF from the Cross River State Ministry of Health were obtained. Global Positioning System (GPS) receivers were used to collect geographic coordinates of the HCFs, which were imported into the ArcGIS 10.3 version to produce relevant maps of the distribution of HCFs. The Nearest Neighbour Analysis (NNA) technique was used to determine the spatial pattern of the physical health care facilities. The spatial accessibility to HCFs was determined using the Time travelled to HCFs and the distance between settlements and HCFs. It was observed that wards 8,9,3,5 in Calabar municipality and ward 12 in Calabar South Local Government Area (L.G.A) have low levels of accessibility to HCFs because the distance traveled to HCFs is greater than the World Health Organization (WHO) standard of 4km. However, patients inwards 4,10,6 in Calabar municipality were highly accessible to HCFs. This is the same observation in wards 9 and 11 in Calabar south L.G.A since the distance traveled to most of the neighboring HCFs is less than 4km. The NNA showed a critical value of -2.808889 at 0.00497significance level, indicating the distribution pattern of health care facilities in Calabar Metropolis to be significantly clustered.

Keywords: Health Care Facilities, Accessibility, Geographical Coordinates, Calabar metropolis

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1. Introduction

Health care has been defined as efforts made to maintain or restore physical, mental, or emotional well-being, especially by trained and licensed professionals, or as the maintaining and restoration of health by the treatment and prevention of disease, especially by trained and licensed professionals (as in medicine, dentistry, clinical psychology, and public health) It is sometimes hyphenated, when used before another noun, such as in health-care providers, and health-care coverage (Merriam-Webster Dictionary Incorporated, 2022) According to writing Explained (2022) Health care (two words) refers to maintenance of one's wellbeing, either by medical means or otherwise. Dictionary.com (2022) described the word health care, as the field concerned with the maintenance or restoration of the health of the body or mind, or as any of the procedures or methods employed in this field, and also as relating to, or involved in

healthcare. Noteworthy is the definitions by Big language.com (2022) which distinguished between healthcare and health care. The variant *Healthcare* include the activity or business of providing medical services. It also includes aspects such as, the set of services provided by a country or an organization for the treatment of the physically and the mentally ill. *Health care* are the efforts made to maintain or restore physical, mental, or emotional well-being especially by trained and licensed professionals, usually hyphenated when used attributively. Healthcare can be rightfully used as a noun and adjective to denote the industry itself or describing specific facility or system. Health Care, however describes those delivering care; individuals or groups. As a guide. Health care (two words) refers to provider actions, while. Healthcare (one word) is a system. These are mostly used interchangeably in some literature. The usage is also British or American relative.

Irrespective of the above terminologies, the fact is that, the problem of inadequate provision of health care facilities in developing countries is having a negative effect on the attainment of universal health coverage. Health care facilities are unevenly spatially distributed across different settings. This is negatively contributing to poor access to health care utilization. The consequences of this are a high rate of maternal deaths, an increasing frequency of malaria-related infants' deaths as well as loss of man-hours. Different scholars have acknowledged that all over the world, the spatial distributions of health facilities and the human populations in need are not matched perfectly over geographical space and time (Luo and Wang 2003; Parker and Campbell 1998). In addition to the unequal geographical distribution of health facilities, the level of income has also been a huge determinant of access to health care. Rosenberg and Hanlon (1996) observed that middle and high-income patients have a higher potential of benefiting from better access to family physicians, as well as having a better health status, while also practicing preventive health care than their low-income counterparts.

Generally, accessibility to medical facilities could be dictated by physical, economic and other environmental barriers, such as mountains and hills, deep valleys, floodable terrains, thick forests, altitudes, affordability, desertification, traffic holdups/congestions, and even lack of adequate road network, topophobia and perceived lack of safety (Macfarlane, 2005; Snow, 1855; Oramasionwu, Daniels, Labreche, and Frei, 2011; Musheke, Ntalasha, Gari, McKenzie, Bond, Martin-Hilber and Merten, 2013; Akintoye, Okon, Ekanem and Idoko, 2013; Oladipo, 2014; Akintoye, Eyong, Effiong, Agada and Digha, 2016; Eyong, Akintoye and Agada, 2016; Eyong, Akintoye, Egena; Chuku, Agada, 2016). Meanwhile, in addition to the spatial difference in health facility distribution, health burdens are equally spatially distributed based on settings. For instance, in areas that are remote from development, the type and volume of waste generation and their improper management, as well as pollution of the environment, can result in a disease outbreak, which also increases the frequency of health care facilities visitation by household members (Digha, Akintoye, Ivagher, Eyong, Okibe, 2016; Digha; Akintoye, Nwaoba, 2017; Digha and Akintoye, 2017; Akintoye, Onuoha, Digha, Eyong and Okibe, 2017). Given that socioeconomic and neighborhood inequalities are significantly correlated with health care accessibility, Council on Graduate Medical Education (COGME), (2000); Rosenblatt and Lishner (1991); Rosenthal, Cornett, Sutcliffe, and Lewton, (2005) pointed out that the inadequacies in health care supply is largely

severe in rural areas and impoverished urban areas.

The Nigerian health system is fashioned and grouped into three tiers of health services, which include; Primary Health Services, Secondary Health Services, and Tertiary Health Services. Primary Health Services, managed at the Local Government Council (LGC) levels, provides basic health services; and may include "dispensaries, clinics, health centers, health post, and comprehensive health center. Secondary Health Service is a "more complex healthcare system saddled with the task of facilitating the actualization of referral cases emanating from the Primary Health Service provision outlets of the LGCs. They are characterized by health care institutions like general hospitals, specialist hospitals, and cottage hospitals, and managed as well as funded by the various State governments in Nigeria. However, the third tier, which is the Tertiary health services, is the most sophisticated. They are funded and managed by the Federal Government of Nigeria and are saddled with difficult and complicated health issues, including especially specialized and referral cases originating from secondary health care tiers, and normally include University Teaching Hospitals and Federal Medical Centre (Peters, Garg, Bloom, Walker, Brieger, and Rahman, 2008).

Access to health care services is a fundamental human right for populations. Thus, it is only ideal and expected that a government should strive to provide high-quality basic health care services to its population. The disparity in spatial distribution of the human population, medical and health care facilities, as well as transportation infrastructure, which characterizes an area, most often results in spatial variations in ease of citizens' access to health care facilities. Powell and Exworthy (2003), observed that in many healthcare systems, adequate, equitable, and easy access to healthcare facilities is often considered one of the main thrusts for equal and easy access to health care. It is essential to ensure that the population, health care facilities, and transportation infrastructure are positioned in a manner that facilitates high spatial accessibility.

The capacity of the majority of urban dwellers to access healthcare has also been a major concern. This is because access to health care is also a function of social class, income, and place of residence within the city. In other words, being an urban dweller does not guarantee access to desired healthcare. According to Galea and Vlahov (2005), the relationship between the provision of health and urban living is complicated and varies between cities and countries. Statistic has shown that even though Nigeria accounts for only 2 percent of the world's total population, it also accounts for about 10 percent of the world's infant and maternal mortality (Ogunlela, 2011). This is centrally due to poor or inadequate access to health care in rural areas, as well as impoverished urban settings. The goal, therefore, has remained to reduce the inequality in access to health care services.

Accessibility is the key element within the health care delivery system. Ideally, all should have equal access to quality health care. Such equal access has come to be recognized as being as essential to public health as individual health status (Aday and Andersen 1974; Culyer and Wagstaff, 1993; Oliver and Mossialos 2004). Penchansky and Thomas (1981) described five dimensions of health access: availability, accessibility, affordability, acceptability, and accommodation. The first two are related to geographical

locations and thus inherently spatial. Among them, accessibility reflects the travel impedance between the population in demand and health facilities and is usually measured in travel distance or time.

The research, aims to contribute the following to knowledge: generate GIS maps showing the distribution of health care facilities in the study area were generated, so that the study can be visually comprehensive. Thus various categories of health facilities in Calabar metropolis will be displayed; produce a spatial accessibility map to health care facilities in each of the wards of Calabar metropolis, to bring to light the areas that are accessible and not accessible; provide a comprehensive list showing the wards, type of health facilities, population and their coordinates in Calabar This study is restricted to all the wards in Calabar Metropolis. The study will be conducted in the two LGA (Calabar south and Calabar municipality) and their twenty-two (22) wards that make up the Calabar metropolis

2. Study Area

The coordinates for Calabar is given variously as Simple decimal standard: 4.95893 8.32695; Decimal Degrees (DD) 4.9589° N, 8.327° E; Degrees and Decimal Minutes (DDM) 4°57.536' N 8°19.617' E; Degrees, Minutes and Seconds (DMS) 4°57'32.1" N8°19'37" E). Specifically, the study is confined to Calabar metropolis that lies between latitudes 4°.0461–4°.0581 north of the equator and longitudes 8°.0151 – 8°.0261 East of the Greenwich meridian with an approximate area of 1480 km2. It covers Calabar Municipality and Calabar South Local Government Areas of Cross River State. The area is bordered in the North and West by Odukpani Local Government Area, in the east by Akpabuyo Local Government Area and in the South by the Atlantic Ocean. metropolis, to aid further GIS application studies on Health facilities in the area

The significance of this study cannot be overemphasized. Derived from the above, this study mapped the spatial distribution of health facilities in Calabar Metropolis, Cross River State, and examines the accessibility potentials of household populations to health facilities in the study area. Findings from this study will enable policymakers to review options for locating health facilities to make for even spatial distribution, taking into consideration the need for increased access to health care services for better health outcomes for populations. Several health facilities have merely been traditionally located for political reasons.

Figure 1, shows the map of Cross River state, while figure 2, shows the map of the study area.

The population of Calabar metropolis according to the 1991 population census (PC) was estimated to be 328,878 persons with a density of 3,626 per square mile. Currently, the city has a projected population of 529,362persons. The relief of the study area is mostly plain except that towards the northern extreme of the town where the relief is dangerously altered by badlands and ravine. The area is drained by a river that flows from the north to the southern part of the area. Calabar metropolis is within the main modified rainforest zone now called oil palm bush. Calabar metropolis has two distinct seasons namely, wet and dry seasons, while the dry season starts from November to March. The wet season starts from April to October.

The climate of Calabar metropolis is a tropical rainy type that experiences abundant rainfall with very high temperatures. Calabar metropolis has two

distinct seasons namely, wet and dry seasons, while the dry season starts from November through December, January, February, and March, The wet season starts from April, through June, July, September, and October respectively. Specifically, the total annual rainfall in the Calabar metropolis ranges between 1599 mm and 3855.9 mm with a mean annual rainfall of 2429.83mm.

The mean monthly relative humidity (percent) in the study area is high during the rainy season with July through to September experiencing the highest level of humidity in the year. This decreases further during the dry season months (December, January, and February) (Oguntoyinbo, 1978)

The temperature in the study area is characterized by little variation in mean air temperature. The annual mean daily maximum air temperature in the area ranged from 28.8oC to 30.2oC during this period. The hottest months are November, December, January, February, March, and April (with means of maximum daily temperature by month ranging from 30.20C to 31.30C) while the coolest months are July to September (with mean maximum daily temperatures by month ranging from 27.00C to 27.50C), which coincide with the peak of the rainy season. The seasonal temperature decline has been ascribed to an expression of the overall cooling of the South Atlantic and the Gulf of Guinea during this period of the year (Oguntoyinbo, 1978).

The city lies within the tropical rainforest Region and the main modified rainforest zone now called oil palm
bush. Its vegetation type is typical of evergreen rainforest and mangrove. The area falls within the equatorial rain forest belt that houses vegetation of green foliage of trees and shrubs.

The main occupations in the study area are associated with civil service, marketing, transportation, security work, civil service, etc. Various educational institutions (the University of Calabar, Cross River State University of Technology, School of Nursing and Midwifery, State and federal civil service training centers). The tourism industry which ranks among the best in the country and several highbrow hotels and recreational facilities, continue to attract local and international tourists. The University of Calabar teaching hospital, Cross River State General Hospital, and Cross River State Psychiatric Hospital are government health facilities, which are available for consultation by the populations in the study area. All of these are associated with a thriving human population

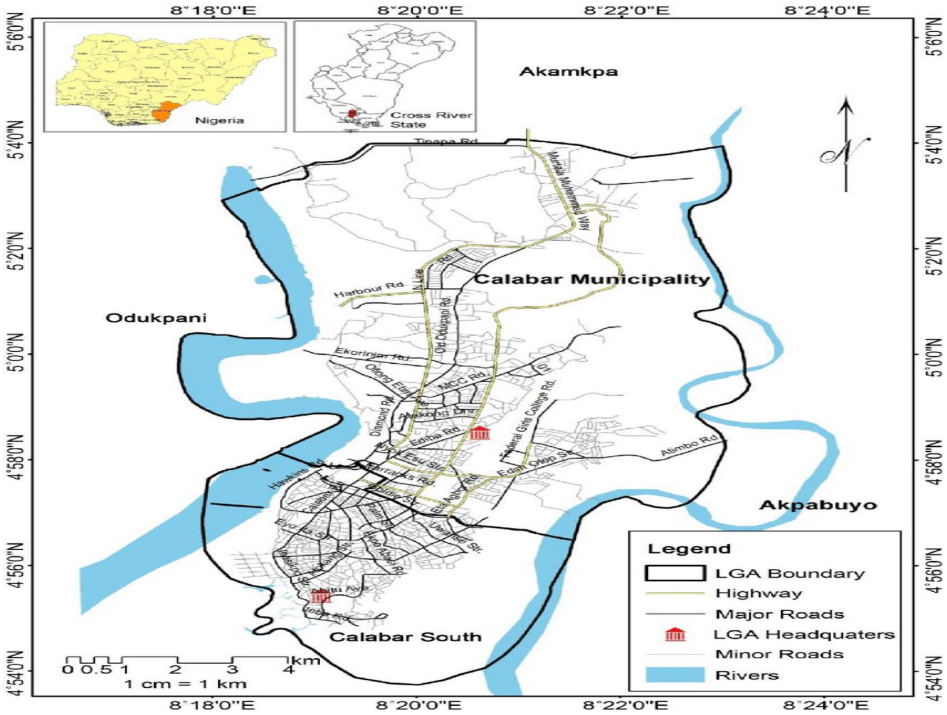

Figure 1: Calabar Municipality and Calabar South Local Government Area Dichotomy

3. Materials and Methods

This section aimed at describing the design and methodology of the study. The chapter is therefore presented under the following subheadings:

3.1 Research Design

The survey research design is used in this study. The design involves the collection and appraisal approach However, the design enabled the researchers to develop a framework to investigate and assess the spatial distribution of health care facilities in Calabar Metropolis, Cross River State. The major types of data used for this study include Primary data and Secondary data**.** The data for this study would be gotten from both primary and secondary sources.

(a) Primary Sources: Data on the exact location and distribution pattern of all health care facilities would be gotten directly from the field through a field survey and the use of Garmin Etrex Handheld Global Position System (GPS) to ground truth on the field to collect individual coordinates (latitude and longitude) of all the healthcare facilities which would be converted into four decimal places in Microsoft office excel and imported into ArcGIS. The health care facilities coordinate data collected from the field using GPS would be plotted on the base map that has been scanned, geo-referenced, and layers extracted. All data gathered would be analyzed using GIS software and presented using tables and maps.

Data on the accessibility of healthcare facilities were obtained from primary sources which involved all the first-hand information, through on-the-spot assessment criteria, recognizance and field survey, structured questionnaire administration, and face-to-face interviews.

The study aimed to make an inventory of health facilities in Calabar Metropolis. In making the inventory of various health facilities in the Study Area, the GPS

devices were used to get the coordinates (longitude and latitude) of each of the health facilities in the study area. The list of the health facilities was obtained from the Cross River State Ministry of health with their respective communities, Political Wards, and LGAs.

This study also examined the spatial accessibility to health care facilities in Calabar Metropolis. Accessibility was analyzed by calculating the proximity from each center of settlement to the Health care facility; linear or road distance and also by estimating the time traveled to each health facility. Analyses in this section were based on the measurement of the accessibility of people residing within a political ward to health care facilities and also the travel time of each of the respondents to reach their preferred health facilities. To determine access to health care facilities in Calabar, the network analyst tool in the ArcMap software was adopted. The tool revealed the service areas from existing health care facilities.

Secondary Sources: The data on various healthcare facilities in the study area would be obtained from a secondary source (Cross River State Ministry of Health). Data on existing literature was gotten from journals, articles, government publications, and publications, while data on the population of the study was gotten from National Population Commission (NPC, 2006) office.

3.2 Sample Size

To determine the sample size, the population of Calabar South and the Municipal LGA of 1991 given by the NPC was projected to 2015 using the population growth rate of 2.54 percent per year. The 1991 NPC census figures were used because it was given at the localities level, which is necessary for this study, and the 2006 census report was deficient. **Table 1:** Projected population and sample size are drawn from each Ward.

The population projection formula is given as:

$P_n = r/100 \times P_o + P_z$…… (*Equation 1*)

Where P_n = Population of year to be projected to

P_o = Base year population (i.e. 1991 population which is given as 328878)

r = Growth rate (i.e. 2.54 given by World Bank, 2015)

P_z = Previous year (i.e. the year that precedes the year under consideration)

The sample size for this study was derived using Smith (2000) formula given as:

Necessary Sample Size = (Z-score)² x Std Dev (1-StdDev) / (margin of error)², where:

Z Score (confidence level-95%) = $(1.96)^2$

Standard Deviation (StdDev) = 0.5

Margin of error = 0.05

Based on a 95 percent confidence level (corresponding to a z-score of 1.96), 0.5 Standard Deviation and a margin of error (confidence interval) of +/-5 percent (0.05), the sample size can be determined thus:

$((1.96)^2 \times .5(0.5)) / (0.05)^2$

$= (3.8416 \times .25) / 0.0025$

$= 0.9604 / 0 .0025$

$= 384.16$

$= 384$

TABLE 1: Projected population and sample size are drawn from each Ward.

S/N	Ward	Locality	1991 Population	2006 Projected Population	2015 Projected Population	Sample Size
Calabar Municipality						
1	One	EdibaAkim Qua	20803	28729	33484	24
		Akim Qua Town	35286	48730	56796	41
2	Two	Ediba Big Qua	1910	2638	3074	2
		OtopAbasi	2300	3176	3702	3
		Akim Barracks	2184	3016	3515	3
3	Three	EsukUtak	1141	1576	1837	2
		ObotOkoho	276	381	444	2
		Ekaobo	151	209	243	2
4	Four	IkotEkaedem	50	69	80	2
		Awakada	150	207	241	2
5	Five	Essien Town	6421	8867	10335	7
		Ekorinim	610	842	982	2
6	Six	Ikot Ishie	5825	8044	9376	6
		Ishie Town	14213	19628	22877	16
7	Seven	Ikot Efa	2309	3189	3717	3
		Ikot Effiong	364	503	586	2
		Ikot Ekpa	2784	3845	4481	3
8	Eight	Ikot Ansa	13006	17961	20934	15
		Ikot Nkebre	457	631	736	2
		Eburutu Barracks	10235	14135	16474	12
9	Nine	Ikot Effanga	5333	7365	8584	6
		Ikot Eneobong	1717	2371	2764	2
10	Ten	Bakoko	489	675	787	2
		Ikot Omin	7872	10871	12671	9
		Abenyo	554	765	892	2
Calabar South						
11	One	Calabar	125084	172741	201335	140
12	Two	Archibong	2902	4008	4671	3
13	Three	Efut Uwanse	21769	30063	35039	25
14	Four	Duke Town	2972	4104	4784	3
15	Five	Cobham Town	5307	7329	8542	6
16	Six	Mbukpa	15197	20987	24461	17
17	Seven	Henshaw	3583	4948	5767	4
18	Eight	Anantigha	12655	17477	20369	14
19	Nine	Obufa Esuk	2338	3229	3763	3
20	Ten	Uwangha Nka	164	226	264	2
21	Eleven	Ine Udo Ndits Okobo	202	279	325	2
22	Twelve	IneUdo	128	177	206	2
		Ine Akan Ufana	137	189	221	2
	Total		**328878**	**454181**	**529362**	**384**

Source: NPC Population Census, 1991, Authors' field computation, 2019*.

Therefore, the sample size is 384. A total of three hundred and eighty-four (384) copies of the questionnaire were randomly distributed to the respondents, while the proportional sampling method was used to determine the number of questionnaire copies to be distributed in each ward of the Calabar metropolis.

3.3 Sampling Techniques

The sampling technique for this research was the simple random sampling method to give the samples a chance of being selected. Questionnaire copies were distributed randomly to each of the 22 wards in the Calabar metropolis, which is made up of both Calabar south. It has twelve (12) political wards and Calabar municipality, which also has ten (10) wards, from which 22 healthcare facilities found in the area were selected as shown in figure 2.

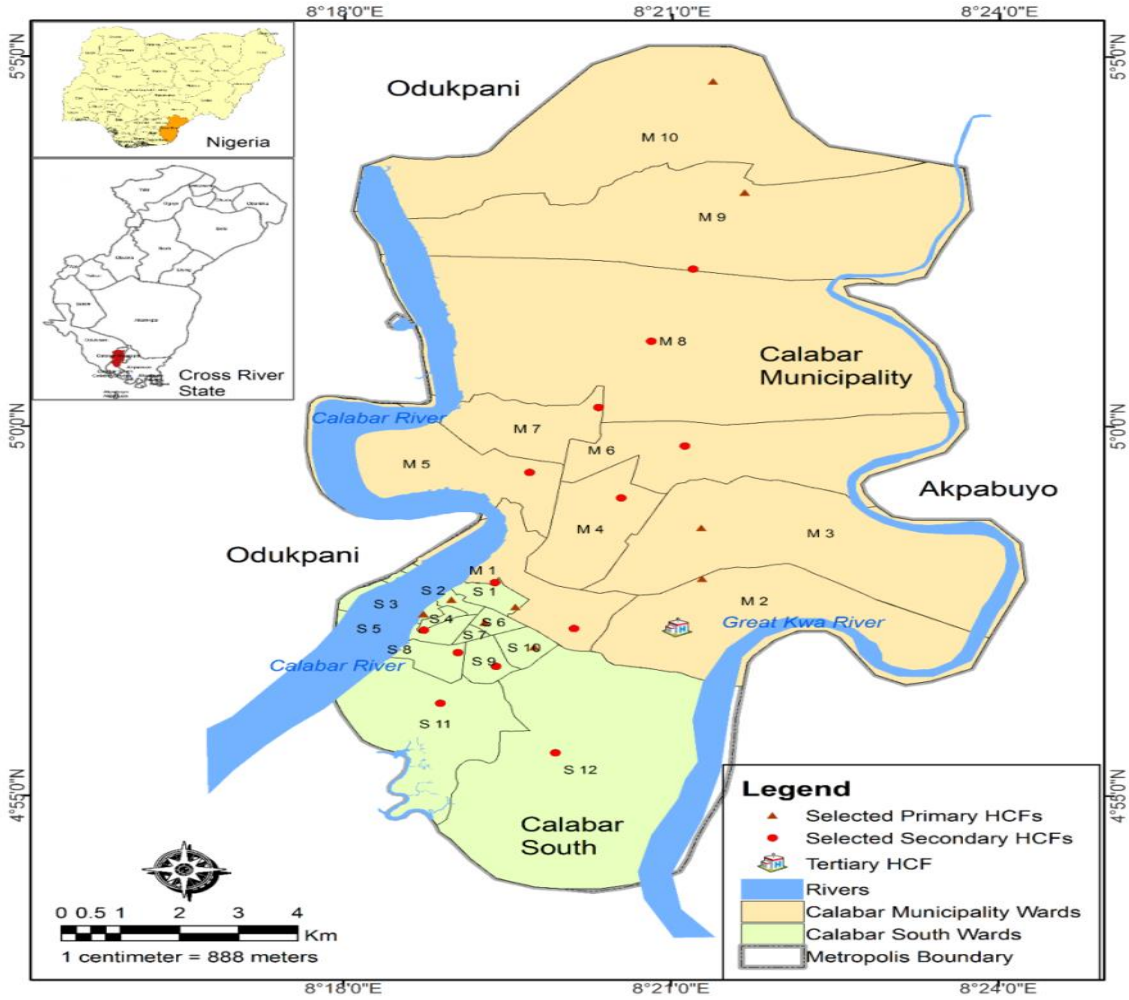

Figure 2: Sampling Areas where health facilities are located in Calabar Metropolis
Source: Author's Analysis, 2019

(i) Questionnaire

This study involves the use of structured and open-ended questionnaire for collecting data from the field. It was the main source of data used for this research. The copies of the questionnaire were distributed proportionally based on the number of respondents sampled in each sampling area in the Calabar metropolis.

(ii) Oral Interview (Face-to-face interview)

The oral interview method was also adopted in the collection of data for this research. There were sessions of Face-to-face Key Informant (KI) and Focused Group Discussion (FGD). Respondents were asked questions about their household size, common family diseases, time taken to reach their preferred health facilities, and the category of health facilities in their respective wards. More explanation and information were obtained since the interview is probing and a learning process.

(iii) Direct Field Observation

There were direct field observations by the researcher on the distribution of health care facilities, spatial patterns, and the

accessibility to these health facilities, which gave more insights into issues during this study.

(iv) Instruments for Data Collection

The data collection instruments used for this research include:

1. Questionnaire
2. Global Position System (GPS) for determination of coordinates of each healthcare facility in the area covered.
3. Field logbook and pen
4. Photography camera

(v) Validation and Reliability of the Instrument

Copies of the questionnaire were constructed by the researcher but checked and scrutinized by independent experts. The questions were well vetted to avoid ambiguity and misinterpretation. The questions were framed to elicit information on major themes reflected in the objectives and hypothesis of the study.

3.4 Techniques of Data Processing

(i) Georeferencing

The administrative map of the study area was scanned and imported into ArcGIS 10.3 version software for georeferencing. Georeferencing enables us to relate space or raster object that has been tied to any geographic reference to coordinate reference object, thereby allowing valorous independent GIS data set to be brought together as an overlay of geographic information.

(ii) Digitalizing: The georeferenced map was digitalized on screen, under the following themes: the local government area and the political ward as polygon, local government area and ward boundary as lines also road network as lines.

More so, to execute the spatial analyses, the network analyst tool in the GIS (ArcMap Software) was used to create a network dataset and determine the service or catchment areas of each facility. A network service area is a region that encompasses all streets that can be accessed within a given distance or travel time from one or more facilities. Service areas are commonly used to visualize and measure accessibility identifying levels of accessibility in areas that are served and not served.

For this study, the distance parameters were used to examine the variation in the accessibility to health care facilities in the study area. The road networks of the study area were edited in ways that allowed the creation of a network dataset. Among the principles of the network dataset, the principle of the beginning of one road (edge) being the end of other roads would be carefully considered and observed.

Furthermore, the travel distance of less than 4 km from every residence to the nearest HCF would then be adopted to determine the service level in the city as recommended by WHO (1997). The areas that are well served and not well served would be distinguished.

To determine the population within different service levels for the HCF categories considered, the service level outputs were overlaid on the acquired satellite imagery. To achieve this, the output of the service level analysis was gridded and overlaid on the satellite imagery in the ArcMap platform. The gridded portions in each service level then aided to estimate the population in each service level. The estimation would be done at a map scale of 1cm: 800m, with each grid covering a span of 300 m by 300 m and at an average of 60 buildings per grid. Also, the coordinates of the midpoint of the grid where the number of buildings per grid would be estimated.

(iii) Attribute Data Table

Attribute data are required data sources often organized in a database format, usually in tabular form, and stored in database management. All attribute data for the healthcare facility obtained from the various health facility management through inventory using the questionnaire were typed in Microsoft excel and saved in CSV (comma delimited) format for analysis.

3.5 Techniques of Data Analysis

Geographic coordinates of health facilities obtained from the field were structured in Microsoft excel. The required number of fields (columns) would be added to the table and the data for all the health facilities in the Calabar metropolis would be entered into corresponding records (rows). The GPS coordinates were imported into the ArcGIS 10.3 interface. As such, all the shape filed holding the relevant data layers were then specially overlaid to create a combination of visual maps of polygon, line, and point feature classes. Consequently, the X and the Y spontaneously displayed the georeferenced location of each health facility in space, along with road network and electoral wards as reflected in their attribute tables. This aided to visualize the distribution of all types of health facilities in the study area.

The study utilized both descriptive and inferential statistical tools of analysis to realize the stated objective vis-à-vis test of the hypothesis. Data were analyzed using percentages, means standard deviation, and frequencies. These were represented in tables, charts, and graphs.

For hypothesis testing, the statistical correlation of the area covered by healthcare facilities and the spatial distribution pattern of healthcare facilities would be analyzed and tested using the Pearson product-moment correlation analysis and Nearest Neighbour Analysis which was based on variance means ratio and related dispersion and index of the cluster. This technique helped in identifying a tendency towards clustered, random or regular distribution of healthcare facilities in the study area, often stated with the formulas as presented below:

$$(1)\quad r = \frac{N\sum XY - \sum X\sum Y}{\sqrt{[N\sum X2 - (\sum X)2]\,[N\sum Y2 - (\sum Y)2]}}$$

Where:

N = represents the number of data

$\sum$ = denotes the summation of the items

$\sum x$ = denotes the sum of X scores

$\sum X^2$ = indicates the x score should be summed and total squared (avoid confusing $\sum X^2$ (the sum of X squared scores) and $(\sum x)^2$ (the square of the sum of the X-scores).

$\sum Y$ = denotes the sum of all Y scores

$\sum Y^2$ = denotes the sum of all Y scores should be squared and then those scores summed

$\sum XY$ = indicates that each X score should be first multiplied by its corresponding Y score and the product (XY) summed.

$$(2)\quad Rn = \frac{D(Obs)}{0.5\sqrt{\frac{a}{n}}}$$

Where: Rn – Nearest Neighbour value

D (Obs) = Mean observed value of the nearest neighbour distance

a = Area under study

n = Total number of points

4. Findings

This section presents the findings of the study. It also focuses on analyzing the demographic data on the respondents, and other aspects of the objectives of the Study. Findings in tables 2 to 5 were obtained largely from collected copies of the questionnaire, which were distributed to respondents and processed for information.

4.1 Demographic Characteristics of Respondents

Few demographic characteristics of the respondents are presented in this section. For instance **Table 2**: presents data on the monthly household income of respondents. This will invariably affect the nutritional level and ability to afford medical and health care patronage by respondents.

Table 2: Monthly income (from all sources)

S/N	Option	Frequency	Percentage
1	Less than 5,000	0	0.00%
2	5,000-20,000	88	21.89%
3	21,000-35,000	103	25.62%
4	36,000-50,000	66	16.42%
5	51,000-70,000	93	23.13%
6	70,000- Above	34	8.46%
	Total	**384**	**100.0**

Source: Field Survey (2019)

Table 3: presents data on the household size of the respondent in the study area. From the table, it is revealed that 157 respondents (40.9 percent) belong to households with 1-4 persons. This is the highest observation. Notably, respondents with family sizes of 12 persons and above were 37 (9.6 percent). This is the lowest observation. This small household size may have been caused by the Christianity religion, largely practiced in this area, which does not encourage marriage to more than one wife, as such the resultant low population size, given the low bearing of children. However, demand for health care facilities, tends to be high, perhaps due to a high level of education and preference for orthodox medicine.

Table 3: Family Size of sampled respondents

S/N	Option	Frequency	Percentage
1	1-4 persons	157	40.9
2	5-8 persons	119	31.0
3	9-11 persons	71	18.5
4	12 persons and Above	37	9.6
	Total	**384**	**100.0**

Source: Field Survey (2019)

In Table 4: we observe the common diseases encountered in each respondents' household. From the table, it is revealed that malaria is the most common family disease, as indicated by 143 respondents (37.2 percent) compared to Sexually

transmitted diseases (STDs) which are indicated by 2 respondents (0.5 percent). According to the Nigeria Malaria Fact Sheet and United States Embassy in Nigeria, there are an estimated 100 million malaria cases with over 300,000 death per year in Nigeria. This is why health facilities must be distributed evenly and equipped with sophisticated apparatus, qualified medical personnel, and also the quality and subsidized drugs, to curb the menace of malaria and other diseases in the country.

Table 4: Common Family Diseases

S/N	Option	Frequency	Percentage
1	Malaria	143	37.2
2	Cough	126	32.8
3	Catarrh	41	10.7
4	Sexually transmitted diseases (STDs)	2	0.5
5	Pneumonia	11	2.9
6	Dysentery	27	7.0
7	Typhoid fever	18	4.7
8	Others	16	4.2
	Total	**384**	**100.0**

Source: Field Survey (2019)

4.2 Spatial Distribution of various categories of Health care facilities in Calabar Metropolis.

Table 5, shows the result of data collected from each of the respondents in the study area on the category of health facility that exists in their ward. From the table, it is revealed that the primary healthcare facilities are dominant in the study area, as indicated by 50.8 percent of the respondents, while other health facilities such as birth attendance centers, Trado-medical centers, Pharmacy/Drug shops, were indicated to be the choice of 2.9 percent of the respondents sampled.

This confirms that primary health care facilities, which are mostly provided by the state or local government are dominant in the study area. Maybe this is because they are usually the first point of call for medical help visit if an individual is suffering from any of the common diseases, such as malaria, typhoid, sore throat, catarrh, and any other First Aid treatment. They are supposed to be closer to the place of residence, and more in number than tertiary healthcare points. Ajala, Sanni, and Adeyinka (2005) stated that this predominance of primary health facilities could be due to the fact that they require a relatively lower amount of investments, since the hosting communities are to provide the building and accommodation to the staff that is posted there. Such staff population is usually not more than two or three persons (A Medical Doctor, a General Nurse, a Medical Record Official, and probably medical laboratory personnel). Also, **Figure 3**, reveals a map showing each of the categories of health care facilities (Primary, Secondary, and Tertiary) in the study area as well as their road connectivity.

Table 5: Category of Health Facilities in Ward

S/N	Option	Frequency	Percentage
1	Primary health facilities	195	50.8
2	Secondary	150	39.1
3	Tertiary	28	7.3
4	Others	11	2.9
	Total	384	100.0

Source: Author's field (2019)

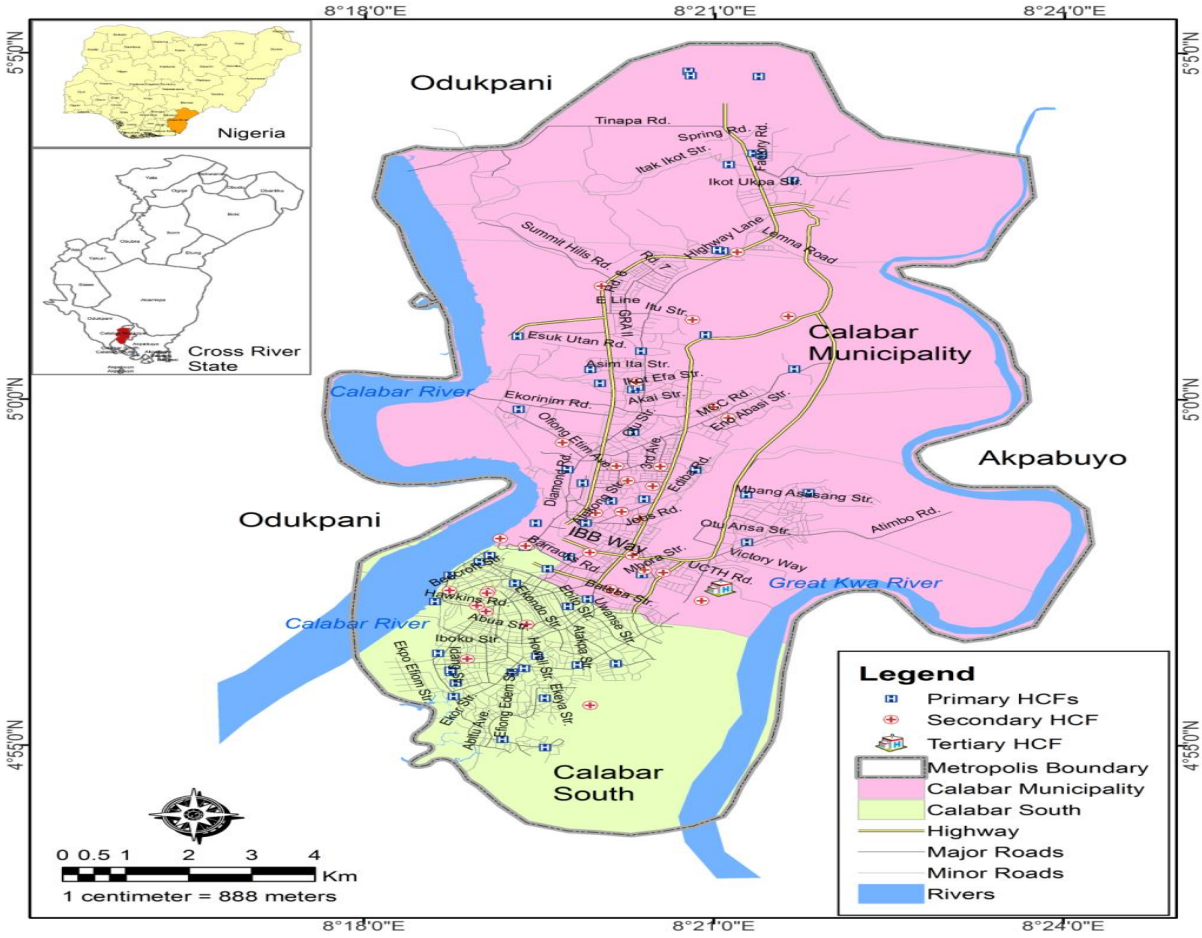

Figure 3: Distribution of Health facilities in the study area.
Source: Authors' Analysis, 2019

4.3 Inventory of health facilities in Calabar Metropolis

Table 6, shows attributes such as names, management and facility types, local governments and wards of Health facilities in Calabar Metropolis.

Table 6: Inventory of various health facilities in Calabar metropolis

S/N	FACILITY NAME	FACILITY TYPE	MANAGEMENT	COMMUNITY	WARD	LGA	LONGITUDE	LATITUDE
1	St Mary Health Centre Efut Abua	Primary	public	Efut Abua	12	South	8.32284941	4.9352304
2	Primary Health Center Aksni Esuk	Primary	public	Afokang	11	South	8.31282064	4.9284288
3	Family Health clinic	Primary	private	Moore road	3	South	8.3228963	4.9643672
4	Primary Healthcare Centre	Primary	public	Nasarawa	10	Municipality	8.3562616	5.0777134
5	PHC Ekorinim	Primary	public	Ekorinim 1	5	Municipality	8.32201344	4.9975682
6	Government Dental centre	Secondary	public	Big Qua	4	Municipality	8.32308642	4.9646933
7	Government House Clinic	Secondary	public	Big Qua	4	Municipality	8.3194553	4.9664561
8	Establishment Staff Clinic	Primary	public	Diamond	5	Municipality	8.33117879	4.9798553
9	Polyclinic Ikot Omin	Primary	private	Ikot Omin	10	Municipality	8.3520079	5.0565232
10	CRUTECH Medical Centre	Secondary	public	Efut Etak Ikot	11	South	8.33233441	4.9263198
11	Primary Healthcare Centre Ikot Effanga.	Primary	public	Ikot Effanga	9	Municipality	8.35063767	5.0354628
12	PHC Anantigha	Primary	public	Anantigha	11	South	8.31977688	4.9181049
13	Mary Magdalene Pry Health Centre	Primary	private	Efut Ekondo	6	South	8.32152017	4.9556885
14	Ikot Ekpo Health Center	Primary	public	Ikot Ekpo	10	Municipality	8.34623627	5.078926
15	Murray Primary Healthcare Centre	Primary	private	Murray	10	South	8.32911508	4.9501618
16	Primary Healthcare Centre Ikot Ansa.	Primary	public	Ikot Ansa	8	Municipality	8.3395182	5.0115778
17	Primary Healthcare Centre Oyo Efam	Primary	public	Efut Abasi Obori	12	South	8.33601705	4.9363568
18	Family Support Primary Healthcare Centre	Primary	private	Big Qua	4	Municipality	8.33996907	4.9759622
19	PHC Anderson	Primary	public	Anderson	4	South	8.31218502	4.957578
20	Nyaghasang Health Centre.	Primary	public	Nyaghasang	3	Municipality	8.3635291	4.9774987
21	Staff Clinic-Ministry of health headquaters	Primary	public	Big Qua	4	Municipality	8.32449257	4.9701811
22	PHC Akim	Primary	public	Akim Qua	1	Municipality	8.3396729	4.9578095
23	Ebuka Primary Healthcare Centre	Primary	public	Ebuka	11	South	8.32588219	4.9161547
24	Duke town Primary Healthcare Centre	Primary	public	Eyamba	2	South	8.31645918	4.9608382
25	Bogobiri Primary Healthcare Centre	Primary	public	Edem Effio Okoho	1	South	8.32699601	4.9587884
26	Okon Ene- Idang Primary Healthcare Centre Extension	Primary	public	Idang	11	South	8.3130844	4.9317006
27	GSS Idang Sick Bay	Primary	public	Idang	11	South	8.31239299	4.9342727
28	Inyene Abasi Assembly maternity home	Primary	private	Efut	12	South	8.32120365	4.9342728
29	Nsibung Ibom Community Health Centre	Primary	public	Nsibung	8	South	8.31012983	4.9512575
30	Peace Medical Centre	Secondary	private	Henshaw Town	5	South	8.31595797	4.9524521
31	Essierebom Primary Healthcare Centre	Primary	public	Idang	8	South	8.31057683	4.9388369
32	O and I health care	Secondary	private	Henshaw town	5	South	8.31777775	4.9538982
33	Dr Lawrence Henshaw	Secondary	private	Essiero	8	South	8.31745523	4.9489225
34	Ikpeme medical centre	Secondary	private	Mbukpa	11	South	8.31476048	4.9374889
35	Police clinic, Calabar	Secondary	public	Akim Qua	1	Municipality	8.33225947	4.9631215
36	Seventh Day Adventist Primary Healthcare Centre	Primary	private	Akim Qua	1	Municipality	8.33193778	4.9518854

37	Peoples specialist clinic	Secondary	private	Akim	1	Municipality	8.33838711	4.9624485
38	Specialist Clinic	Secondary	private	Akim	1	Municipality	8.3394382	4.9713411
39	Esor Clinic	Secondary	private	IKOT UDUAK	6	Municipality	8.35240833	4.9977153
40	Amazing specialist clinic	Secondary	private	IKOT UDUAK	6	Municipality	8.34990381	4.9981432
41	Primary Healthcare Centre Ikot Effanga Mkpa	Primary	public	Ikot Effanga Mkpa	9	Municipality	8.350381851	5.0359708
42	HEALTH CENTER KASUK	Primary	public	KASUK	7	Municipality	8.33992236	5.0026952
43	Spring Road Specialist Clinic	Secondary	private	Essien Town	5	Municipality	8.32833349	4.9895448
44	University of Calabar Teaching Hospital	Tertiary	public	Eta Agbor	2	Municipality	8.35086402	4.9546659
45	Mevom specialist clinic	Secondary	private	Akim	1	Municipality	8.34007248	4.9589308
46	University of Calabar Medical Centre	Secondary	public	Eta Agbor	2	Municipality	8.34202089	4.9546841
47	Primary Healthcare Centre Ikot Nkebre	Primary	public	Ikot Nkebre	9	Municipality	8.355574608	5.0597674
48	Victoria Itam Secondary	Secondary	private	Big Qua	4	Municipality	8.33679527	4.973001
49	Federal Neuro psychiatric Calabar	Secondary	public	Henshaw Town	5	Municipality	8.31827163	4.9535183
50	Nyahasang Primary Healthcare Centre	Primary	public	Nyahasang	3	Municipality	8.35459592	4.9770695
51	Primary Healthcare Centre, Edim otop	Primary	public	Edim otop	2	Municipality	8.35431896	4.9658425
52	General Hospital Calabar	Secondary	public	Akim Qua	1	Municipality	8.33623724	4.9535541
53	Army Medical Centre, Eburutu Barracks	Secondary	public	Ikot Ansa	8	Municipality	8.34689033	5.0191382
54	Primary Healthcare Centre	Primary	public	Ikot Ekpo	10	Municipality	8.34654192	5.0779403
55	Bakor Medical Centre	Secondary	private	Federal Housing Estate	8	Municipality	8.33385904	5.0272371
56	Mission Hill Clinic	Primary	private	Ikot Nkebre	9	Municipality	8.35619439	5.0595582
57	Nosam Clinic	Primary	public	Federal Housing Estate	Ward 8	Municipality	8.34218582	5.0245581
58	Efkam Clinic	Secondary	NA	Ediba	4	Municipality	8.34123322	4.9790848
59	Unicem clinic	Secondary	private	Big qua	4	Municipality	8.33608301	4.9839085
60	Primary Healthcare Centre Ikot Anwatim 1	Primary	public	Ikot Anwatim 1	7	Municipality	8.3339576	5.0053204
61	Adi Specialist Clinic	Primary	private	Akim	1	Municipality	8.32927303	4.9620375
62	Akai Efa Primary Healthcare Centre	Primary	public	Akai Efa	6	Municipality	8.36141648	5.0073036
63	Victoria Itam Secondary	Secondary	private	Big Qua	4	Municipality	8.33681547	4.9729038
64	Idang Primary Healthcare Centre	Primary	public	Idang	11	South	8.31232313	4.9347519
65	Marian Clinic	Secondary	private	Kasuk,Ikot Ansa	7	Municipality	8.33953441	5.0038093
66	Elyon Foundation Medical Centre	Secondary	private	Big Qua	4	Municipality	8.33306136	4.9726288
67	Primary Healthcare Centre Musaha	Primary	public	Efut Anantigha	12	South	8.32583984	4.9280143
68	Ikot Ishie Health center	Primary	public	Ikot Ishie	6	Municipality	8.33842182	4.992073
69	Primary Healthcare Centre	Primary	public	Ikot Anwatim 2	7	Municipality	8.33228371	5.0071781
70	Primary Healthcare Centre	Primary	public	Cobham Town	3	South	8.317916393	4.9623603
71	Inyene Abasi Assembly maternity home	Primary	private	Efut	12	South	8.32120365	4.9342728
72	City Clinic	Secondary	private	Big Qua	3	Municipality	8.34215889	4.9797989
73	Immanuel Infirmary	Secondary	private	Ikot Effanga	9	Municipality	8.35093831	5.0345006
74	NYSC/CBHC	Secondary	public	Efut	9	South	8.32324158	4.9458212
75	School health services	Primary	public	Ekpo Abasi	12	South	8.32471113	4.9382105
76	Ukpong clinic and maternity	Secondary	private	Big qua	4	Municipality	8.33764495	4.9803727
77	Health Center	Primary	public	Abenyo	10	Municipality	8.38147527	5.0758956
78	Progress Clinic and Maternity	Secondary	private	AKIM	1	Municipality	8.34277741	4.9582912
79	Primary Healthcare Centre, Esuk Utan	Primary	public	Esuk Utan	8	Municipality	8.32186087	5.0151607
80	Divine Maternity	Primary	Private	KASUK	6	Municipality	8.33911416	5.0029414
81	Hannah Foundation Clinic and Trauma Centre	Secondary	Private	Akim Qua	4	Municipality	8.34232462	4.9838059
62	Cross River State Eye Care Programme Centre.	Secondary	public	Akim Community	2	Municipality	8.335149	4.9543547
83	National Blood transfusion service Calabar Centre	Secondary	public	Henshaw Town	5	South	8.31614187	4.9503247
84	Atekong Primary Healthcare Centre	Primary	public	Atekong	4	Municipality	8.33524996	4.9755261

85	Primary Healthcare Centre Okoho Ephraim	Primary	public	Efut	12	South	8.33049055	4.9360383
86	PHC Big Qua	Primary	public	Big Qua town	4	Municipality	8.33165664	4.9702012
87	Diamond Health centre	Primary	public	Diamond Hill	5	Municipality	8.32904748	4.9830467
88	Health Center	Primary	public	Ikot Eneobong	9	Municipality	8.36112672	5.0526806
89	PHC Ediba	Primary	public	Ediba Qua	3	Municipality	8.34734156	4.9830076

Source: Fieldwork, 2019 (Cite this article if this data is used in future research)

Table 7, shows the number of health facilities in each ward of the Calabar metropolis and also the 2015 projected population of each of the wards in the study area. From the table, it is revealed that ward 4 and 1 of Calabar municipality has the most health care facilities in the metropolis with an observed frequency of 16 and 14 respectively. Notably, ward 7 of Calabar south LGA has 1, as well as ward 4 of the same LGA

Table 7: Number of health facilities in each ward

S/N	Wards	No. of HCFs	2015 projected population	LGA
1	12	7	427	Calabar south
2	11	8	325	Calabar South
3	3	2	35039	Calabar south
4	1	1	201335	Calabar south
5	2	2	4671	Calabar south
6	5	3	8542	Calabar south
7	4	1	4784	Calabar south
8	7	1	5767	Calabar south
9	9	4	3763	Calabar south
10	10	2	264	Calabar south
11	8	2	20369	Calabar south
12	6	2	24461	Calabar south
`13	10	5	13563	Calabar municipality
14	5	5	11317	Calabar municipality
15	4	16	321	Calabar municipality
16	9	5	12135	Calabar municipality
17	6	7	32253	Calabar municipality
18	8	9	17210	Calabar municipality
19	7	3	29718	Calabar municipality
20	3	3	2524	Calabar municipality
21	1	14	90280	Calabar municipality
22	2	4	10291	Calabar municipality
		102	529,362	

Source: Fieldwork, 2019

4.4 Spatial Accessibility to Health Care Facilities in Calabar Metropolis

Table 8, shows the time is taken to reach the preferred health facility by the respondent, from the table it is seen that people that whose travel time is between 21-40 minutes is the highest with 34.4 percent while the least percent is between 2 hours and above which represent 7.6 percent.

Table 8: Estimated travel time to preferred health care facility by the respondents.

S/N	Option	Frequency	Percentage
1	Less than 5 minutes	37	9.6
2	5-20 minutes	83	21.6
3	21-40 minutes	132	34.4
4	41-59 minutes	51	13.3
5	1-2 Hours	52	13.5
6	2 hours and above	29	7.6
	Total	384	100

Source: Author's fieldwork (2019)

WHO (1997) has stated that 4km is the farthest distance that should be traveled to access a healthcare facility in urban or rural areas. Therefore, from the analyses in **figure 4**, it can be observed that ward 8,9,3,5 of Calabar municipality has less level of accessibility to health care facilities as well as ward 12 of Calabar south because the distance traveled is greater than 4km to some of its health care facilities. It was also observed that ward 4,10,6 of Calabar municipality was greatly accessible to health facilities as well as ward 9 and 11 of Calabar south because the distance travailed to most of its health facilities is less than 4km.

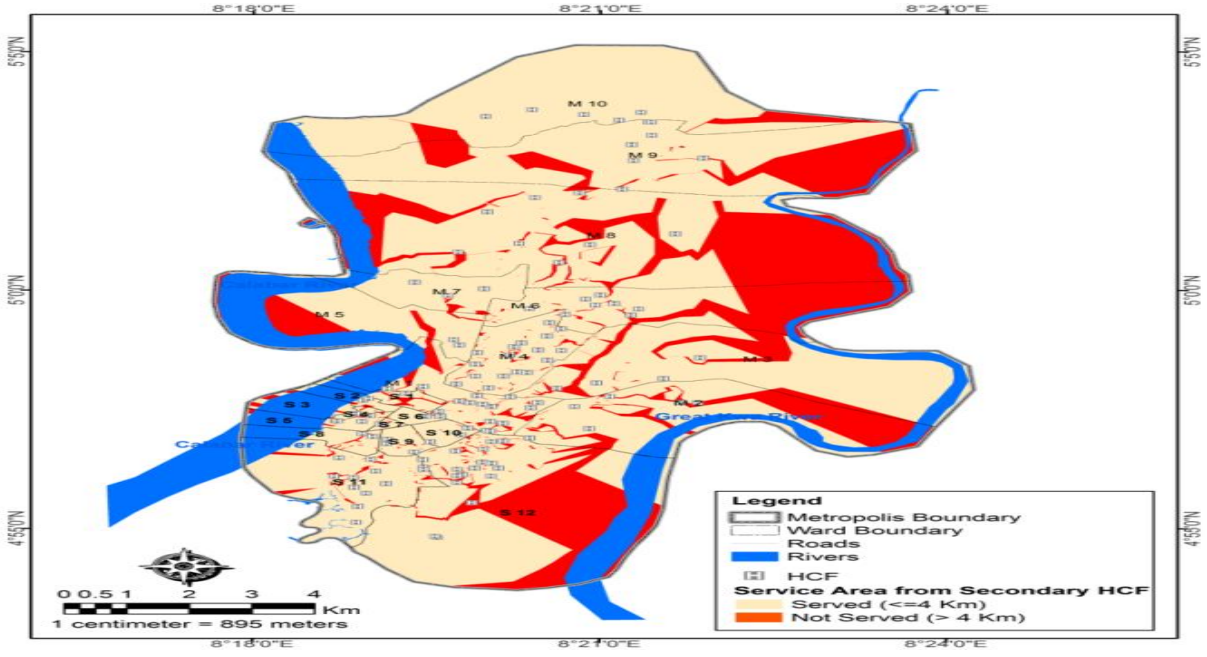

Figure. 4: Accessibility to health care facilities in Calabar metropolis.
Source: Authors' Analysis, 2019

4.5 Testing of Hypothesis

In this section the null hypothesis states that: H_0: Health care facilities in Calabar Metropolis are not significantly clustered (and its H_1: Health care facilities in Calabar Metropolis are significantly clustered) alternatives were considered. The output of the analysis shown in **Table 9 (see also figure 5),** shows that the average nearest neighbor ratio is less than 1 (0.843).

This implies that the pattern of distribution of HCFs in Calabar Metropolis exhibits clustering. Based on this, the alternate hypothesis is accepted, that HCFs in Calabar Metropolis are significantly clustered. The clustering of HCFs would have negative implications for users, especially by deterring geographic access to the facilities at the areas with dispersed HCFs.

Table 9 : Summary of Average Neighbour Statistics

Average Nearest Neighbour Summary

Observed Mean Distance	1461.2312 meters
Expected Mean Distance	1321.5732 meters
Nearest Neighbour Ratio	0.843483
Z- score	-2.808889
P-value	0.004979

Source: Authors' Analysis, 2019

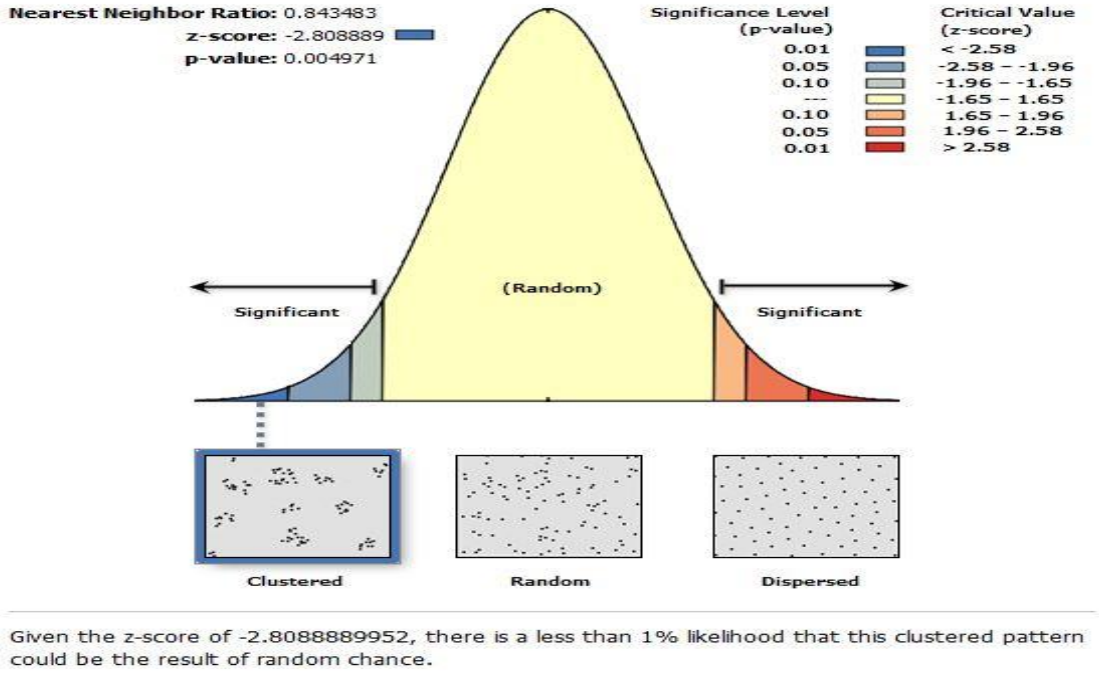

Figure 5: Pattern of health care distribution in Calabar metropolis
Source: Authors' Analysis, 2019

5. Summary, Conclusion, and Recommendations

This part of the study presents the summary, conclusion of the work as well as the recommendations of this study. the summary shows the distribution pattern of healthcare facilities and their accessibility. Recommendations were made for further research and also the contribution to knowledge, this study was concluded based on findings.

6.1 Summary

GIS techniques for mapping were used to analyze the spatial distribution and, accessibility of health care facilities in the Calabar metropolis, based on WHO standards. Also, the updated list consisting of all the health care facilities in the study area was obtained from the Cross River state ministry of health.

The findings showed that Primary Health care facilities which are provided by the state or local government are predominant in the study area and it constitutes 50.8 percent, followed by secondary Health care facilities and Tertiary health care facilities with 39.1% and 7.3% respectively. The spatial pattern of health care facilities in the Calabar metropolis was proven to be significantly clustered and this might be the cause of its randomness.

The contribution to Knowledge by this study is diverse. For instance, the research contributed the following to knowledge in the study area:

i. GIS maps showing the distribution of health care facilities in the study area were generated so that the study can be visually comprehensive, thus various categories of health facilities in Calabar metropolis were displayed.

ii. The spatial accessibility map to health care facilities in each of the wards of the Calabar metropolis was also generated to bring to light the areas that are accessible and those not accessible.

iii. A comprehensive list showing the wards, type of health facilities, population and communities served, in the Calabar metropolis was formulated to aid further GIS studies on Health facilities in the area.

6.2 Recommendations

In order to solve the problems associated with the spatial pattern of health care facilities in the Calabar metropolis, we hereby make the following recommendations:

i) To improve the access to healthcare facilities, the government should build more healthcare facilities in wards that have less accessibility rate, such as wards 5, 8, 9 in Calabar municipality and also ward 12 of Calabar south LGA.

ii) Government should employ more qualified medical personnel in all public healthcare facilities, especially the primary healthcare facilities.

iii) The medical practitioners should be given incentives to stay in most of the rural areas to enhance the

utilization of primary health care facilities

iv) More sophisticated medical apparatus should be acquired and quality and subsidized drugs should be provided by the government to reduce medical tourism

v) Health care centers in the study area should be rehabilitated and well managed to enhance sustainable development

vi) Government should make sure that health facilities in the study area are relatively evenly distributed to meet WHO standards and also to reduce clustering.

vii) Improvements in road network development should be encouraged, ambulatory services improved, while transportation costs for patients can be subsidized

viii) The National Health Insurance Scheme could be fine-tuned to cater for transportation assistance to patients, resulting in improved accessibility

6.3 Conclusion

In Nigeria, health facilities are generally unevenly distributed. This uneven distribution can be observed in the ways some health care facilities are concentrated in one area to the detriment of others. This often resulted in spatial inequality as greatly shown in Nigeria's socio-economic and political landscape. Hence, this study analyzed the spatial distribution of health care facilities and also the spatial accessibility to them in the Calabar metropolis vis-à-vis various GIS analytical techniques and tools. The study revealed that primary health care facilities are dominant and widely distributed across each of the political wards of the study area. Since the health care facilities are unevenly distributed given the clustering pattern of the facilities in a particular section of the metropolis, leaving the other section less accessible. Therefore, there is a dire need for the various stakeholders in the health sector, including Governmental Organizations and Non- governmental organizations, to come together and put more efforts into making health facilities to be accessible to all household members, as regards availability and affordability.

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