

# Locational Distribution and Accessibility Analysis of Primary Health Care Facilities in Enugu Metropolis, South-East, Nigeria

Ngene Charles<sup>1</sup> & Obinna Ubani<sup>2\*</sup>

<sup>1</sup> Department of Urban & Regional Planning, Enugu State University of Science and Technology, Agbani, Enugu, Nigeria

<sup>2</sup> Department of Urban & Regional Planning, University of Nigeria, Enugu campus, Enugu 430001, Nigeria

\*Corresponding Author

Obinna Ubani - E-mail; [obinna.ubani@unn.edu.ng](mailto:obinna.ubani@unn.edu.ng)

D.O.I: 10.56201/ijgem.v10.no1.2024.pg94.113

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## Abstract

*In recent years, there has been a surge in empirical research focused on understanding the nature, effectiveness, adequacy and potential advantages of Primary health care facilities (PHCF) particularly in western and Asian nations. However, there remains a notable dearth of studies investigating locational distribution and accessibility pattern of these primary health care facilities as a basis for the effectuation of this tier of health care system at the community levels in sub-Saharan African countries like Nigeria. The aim of the study is to analyze the locational distribution and accessibility pattern of existing primary health care facilities in Enugu urban using GIS. The research gathered data from a survey involving 1300 house hold heads from 15 neighborhoods in Enugu urban. Employing a questionnaire method, GIS tools, buffer analysis index and the nearest neighborhood analysis, both pictorial and quantitative data were collected. The Nearest neighbourhood analysis result showed that the PHCF has not optimally located and the Buffer analysis result suggests that the PHCF were located far away from the residents. The findings further showed that PHCF were not adequately distributed in Enugu urban. This study has provided a working guideline for the location and distribution of PHCF in Enugu as well as establish a health care facility database which will help government or non-governmental health care planners make better decisions needed for robust and sustainable health care program in Enugu and other Nigerian cities*

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**Keywords:** GIS, Health, Primary, Urban, Cities

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## 1. Introduction

Public services and facilities are essential for residents in any city all over the world in general, and in developing countries in particular. Governments start to rethink the delivery of public services in order to enhance their quality and quantity, to meet public's needs and expectations (Carvalho, et al, 2010). Assessing the efficiency of public services is multidimensional and

includes several factors such as geographic and financial accessibility, availability, quantity, distribution, quality, and clients' satisfaction. However, spatial distribution is of great importance. Thus, spatial analysis of public services distribution gains an increasing attention in the last decades from both geographic and environmental perspectives (Elzahrany,2003). Moreover, the issue of spatial equity of urban public facilities has proliferated recently from both planning and geographic points of view, trying to arrive at the so-called spatial justice. Diagnosing the current situation of a public service is quite essential in planning its new spatial locations in order to increase the service availability and accessibility to residents. (Singh and Kaish ,2013). Geographic Information System (GIS) plays an important technical role in spatial analysis of geographic features. The public service and facility been considered in this study is the Primary Health Care Facility (PHCF)

Health facilities in Nigeria have evolved through a series of historical development including a succession of policies and plans which had been introduced by various administrations. However, the health facilities are inadequate in meeting the needs and demands of the public. Man through technology has continued to expand his land holding capacity and to improve his wellbeing. (Jiawei, et al, 2021). This is because he believes that economic survival or self-sufficiency is synonymous with high standard of living. Also, various religious bodies and private agencies established hospitals, dispensaries and maternities in different parts of the country without considering the convenience of residents at patronizing them. Primary Healthcare (PHC) service delivery in Nigeria has been faced with a lot of problems some of which are inadequate manpower, obsolete equipment and unavailable drugs etc. Depending on which perspective of observation, some have applauded the efforts of the government in providing grassroots healthcare services whereas in some quarters such services are not adequately provided. This is evidenced in the number of ailing hospitals across the country. Besides, most of the government-owned hospitals are not optimally located which implies that community-based accessibility to these medical facilities has been compromised.

Urbanization in these third world countries brings to its wake many advantages and disadvantages. The disadvantages usually have to do with difficulties in controlling urban growth and making available the resources to meet the increase needs and demands for essential public services like education, housing and most especially health (Luo & Wang, 2003). There are numbers of primary health centers in Enugu urban area but it has not been established whether this primary health centers and facilities are adequate and equally distributed. Enugu State does not have existing literature on PHCF and the sitting of these PHCFs seem to be arbitrary in nature; as space standards that should constitute the fundamental location parameters were apparently not considered. Moreover, there have been the geographic mal-distribution of regional, urban health care facilities in Nigeria and most of the existing facilities are haphazardly distributed. This situation may be corrected by using reliable data with the Geographic Information System. (Manortey and Acheampong, 2016).

The distribution of primary healthcare services in Enugu has been characterized by significant disparity. Such disparity is shown in the ways some of these medical facilities seem to be concentrated in one region at the expense of others. This often resulted in spatial inequality that

characterizes Nigeria's socio-political landscape. Also, this inequality places pressure on the facilities which are already inadequate. There is need to ascertain how this spatial inequality can be reduced to favour patients patronizing these healthcare facilities. Even though the government has shown serious commitment towards addressing these inequalities, more is still expected in the areas of technical knowhow. However, attempt to address such disparity from technical perspective may require the use of a cut edge information management tool such as the geographic information systems (GIS). Thus, the need to use the GIS geo-referencing tool to resolve this ugly trend is of essence in this study. The existing PHCF facilities are seemingly haphazardly distributed and this situation may be corrected by using reliable data with the Geographic Information System (GIS). These systems contain important tools that can help in health delivery service planning and decision-making processes. The cardinal objective of this study is to analyse the spatial and locational distribution and accessibility pattern of existing primary health care facilities in Enugu metropolis using GIS. It was hypothesized in the study that the spatial distribution of existing primary health care facilities in Enugu Urban areas is not equitably distributed

## **2. Literature Review**

### **2.1 Factors influencing the use of primary health care**

Primary healthcare has been described to be as the essential healthcare that is based on socially acceptable methods that are made universally accessible to families and individuals in communities through the full participation of these individuals and at a cost the community can be maintain at every stage of development in the spirit of self-reliance and self-determination. (Olayiwola, and Adeleye, 2005). On the factors that influence the use of these PHCF, Buor (2003) in his research at Ahafo – Ano, Ghana posited that distance was the most important determinant to the utilization of primary healthcare. In the same vain, Tsawe, and Susuman, (2014) in their study at Eastern Cape, South Africa where they investigated why women failed to use available maternal health care suggested that as part of measures to increase the usage of healthcare services by female residents in South Africa, intentional educational programs tailored at educating the women on the importance and benefits of seeking maternal healthcare should be included in media broadcasts especially in the rural areas. Wandera et al. (2015) investigated access to healthcare by older persons in Uganda and found that for older people from poor households, access to healthcare was improved for them. The government subsidised the transport fare for the aged population that have ailments like heart disease, diabetes, and hypertension. The study noticed that the ease of access to PHCF in Uganda was a function of household income and health needs factors such as severity of illness and difficulty with mobility

Exavery (2011) found age to be a significant determinant of primary healthcare utilization in rural Ghana. The study found that old age predisposes people to some diseases and ailments (such as joint pains, predisposing them to having difficulty with lifting up objects), that require that they use primary healthcare facilities available to them. This therefore increases the likelihood that they will use primary healthcare services available more readily than younger people who may not have such conditions. The finding therefore submitted that age as well as sex, marital status as predisposing factors to the use of PHCF.

Redondo-Sendino et al (2006) studied on the relationship between gender and utilization of healthcare facilities and found that women as compared to men had higher utilization of healthcare facilities than men. The study was conducted with a sample of 3030 respondents who were non-institutionalized, 60 years and above. Their study having isolating some predisposing factors such as age, head-of-family status, marital status and educational level posited that women used healthcare facilities and services more than men in Spain. In the same vain. Geitona, et al (2007) noted that income was a strong predictor of primary healthcare usage in Greece. In their study on investigating some residents' demographic characteristics that influence utilization of primary healthcare in Greece submitted that in areas where majority of the residents are below poverty level, patronage to the primary healthcare facilities and services were comparatively low, this was attributed to financial constraints. Similar findings were noted in the study of Zhang et al, (2018) in their study on social status and determinants of healthcare utilization among older migrants into China. The findings of the study showed that income was one of the leading determinants of primary healthcare usage. It was also evident in that study that migrants who earned less than 3000 yuan were not so willing to visit a doctors in PHCF when sick but those with an income of more than 7000 yuan were willing to visit a doctor when they fell sick.

Lega and Mengoni (2008) used a qualitative approach to explore the reasons why non-urgent patients preferred to choose an emergency department rather than a PHC institution. The results indicated that this preference was determined by the higher trust, convenience, and satisfaction with previous visits experience. A study by Northington et al (2005) equally noted that patients' choice of health care institutions in the United States was associated with a lack of medical insurance. They found that residents who had access to medical insurances are more predisposed to using the PHCF in the area. Furthermore, Berendsen et al, (2010) explored elderly individuals' perception of preferences for PHCF and issues related to the non-medical attributes of PHCF. The findings suggested that general practitioners' knowledge and attitudes might affect elderly individuals' preferences for PHC. Another study by Wang et al (2010) further posited that the determinants of patients' health-seeking behavior were affected by the type and severity of the disease, the hospital's medical technology, and cultures. Zhang et al (2010) in their study on factors influencing patients' choice of primary health care institutions shows that the distance between the medical institution and the patient's residence, the patient's economic status, and the severity of the disease were strong significant driver to the visits to PHCF.

## **2.2 Locational distribution of healthcare facilities in Nigeria**

There are scattered accounts on accessibility, distribution and utilisation of health facilities with regard to other states of Nigeria aside Enugu State, particularly Bayelsa, Edo, Osun and Oyo. Onokerhoraye (1999), Omofonmwan (2003), Ogunjumo et al (2005) and Owoola (2002) carried out the study on some of the factors that determine the location of healthcare facilities in their chosen study areas and drew some conclusions based on their findings. In the study of access and location of modern healthcare facilities in the petroleum-producing region of Nigeria, the case study of Bayelsa State, Onokerhoraye (1999) employed the Central Place Theory of Walter Christaller to analyze the healthcare delivery system in Nigeria and Bayelsa State. In order to achieve this, he postulated that the hierarchical system of Christaller reflected in space, the geographical arrangements of service outlets in which a particular area tends to have numerous primary health facilities and very few tertiary facilities, if at all. He further surmised that for

efficiency to be attained in the provision of healthcare facilities in any locality, the threshold population must exist within the range of that category of healthcare service. He also observed that the capability of any geographical area to satisfy the threshold requirements for the provision of a particular category of healthcare facility will depend on the pattern of population density.

In his study, Onokerhoraye (1999) discovered a glaring disparity in the distribution of health facilities in Bayelsa state. There were six functioning tertiary and secondary health facilities in Bayelsa state in 1998. These establishments which are made up of one tertiary health centre and five secondary centres are located in four of the eight local government areas. These facilities were located in the eastern part of the state, while the western part has none located in it. In like manner, there are 29 functioning primary health establishments in the state in 1998. However, there is the concentration of most of them in the northern part of the state while the south with a greater population density, has fewer primary health centres. He also discovered in this study that within the individual local government areas, respondents in settlements where primary health establishments are located indicated the use of these facilities compared with those in communities where there are no such establishments. Thus, he reeled off the factors influencing the utilization pattern of modern healthcare facilities in Bayelsa state to include the level of formal education, level of income, cost of the services, facilities available in the health establishments, availability of alternative medical attention in the locality, perception of the attention received in the modern health establishments and the distance to the centres in terms of travel cost and time of reaching the health centre. Accordingly, Onokerhoraye emphasized that one of the most important determinants of the use of modern health establishments is their accessibility to the people. He concluded that the petroleum-producing communities have the poorest healthcare services in the country largely because of inadequate attention given to the area in terms of the allocation of resources despite the fact that the region produces most of the wealth of the country. Further, the inaccessibility of the vast majority of the population in Bayelsa state to modern healthcare services has contributed to the prevailing attitude of the people towards modern healthcare services. However, it is pertinent to note that the prevailing pattern of the location and distribution of healthcare facilities in Bayelsa state is influenced by the geographical and environmental characteristic of the state. Local government areas closer to the mainland areas attract more attention in the provision of healthcare facilities than those in the riverine because they are more accessible. The litany of criticisms on this theory particularly on the difficulty to operationalize it makes it apparently inoperable as a basis for the location of healthcare facility in Enugu State. However, the political/administrative principle might have variously influenced the location decisions of existing healthcare facility in the study area.

Omofonmwan (2003) used the Nearest Neighbour Analysis Model in the study of spatial distribution of health services in Esan area of Edo State. The study revealed that there are six general hospitals in the area in addition to a specialist/teaching hospital located within the region. According to him, six hospitals yielded a theoretical mean access radius of 13 kilometres per unit. This working radius surpasses the World Health Organization (WHO) standard of 16 kilometres per hospital. (WHO, 2008). Also, there are 36 PHCF distributed hexagonally in the region. The working distance per unit is 5.4 kilometres. The study according to him shows that 31 additional units are required to meet the WHO standards of 4 kilometres access radius per PHCF. Omofonmwan (2003) concluded based on this deduction that some of these units may be



economically unviable, health services are most basic of the human needs, and as such economic considerations should not be allowed to outweigh the welfare consideration of health service delivery.

Owoola (2002) carried out a study of three local government areas (LGA) in the northern part of Oyo state based on the title: *Between Policy and Practice: A Spatial Decision Support System-Based (SDSS) Assessment of Facility Location Planning in Nigeria*. In this study, he concentrated on Kajola, Iseyin and Ifedapo LGAs. The three LGAs constitute the Oke Ogun area of the state. It is an area perceived as being deprived of basic facilities and infrastructure compared to other parts in the state. In 1985, there were 40 dispensaries in 31 settlements representing only 6.2 percent of the settlements but containing 71.8 percent of the total population in the study area. In 1996, 8 more dispensaries were built in 6 settlements in the study area. Out of these 6 settlements, 2 were already dispensary locations, increasing the number of settlements with dispensaries to 35. These settlements contain 72.1 percent of the total population in the study area. Thus, by 1996, the dispensary to population ratio improved to 1:17,433. Owoola inferred that in terms of absolute level of geographic coverage defined as actual population and settlements served with services, it was obvious that government had not considered the dispersed nature of settlement distribution in the study area in locating these services. He stated that whereas 72.1 percent of the population has access to dispensaries, this figure represented 7.04 percent of the settlements served with these facilities and more so with little or no spread in the locations chosen as service centres even when new facilities were being established. Owoola concluded that 93 percent of the settlement has no dispensary; a situation which has made location accessibility more or less fixed in the study area and therefore negated the objective of equity in facility distribution. To justify and statistically validate this assertion, he hypothesized that the distribution of health facilities does not follow the dispersed pattern of population distribution. Using the product moment correlation coefficient ( $r$ ) between the number of dispensaries located and the population size of settlements for the two periods,  $r$  values of 0.73 and 0.84 were obtained respectively. The test of significance of  $r$  at 0.05 levels indicates that the critical  $t$  of 1.96 is less than the calculated  $t$  of 23.88 and 34.42 for dispensary services in the two periods respectively.

Pindiga, (2001) in their study of Bivariate Analysis of factors of location of healthcare facility in Bauchi state identified the problem of dichotomy in the location of public healthcare facilities in favour of urban areas. Further, they highlighted the observed uncoordinated location and multiple siting of these facilities far away from the residences of the patrons. The study also revealed that the dominant factors influencing the location of public healthcare were distance of public healthcare facilities from patients' residence, patients' mode of transport and transport cost incurred by patients patronizing these facilities. Other factors that influenced the use of facilities were affordable cost of treatment, efficient medical personnel, nearness to residence and availability of medical facilities. However, they further discovered that the choices of doctors by patients were influenced by acceptability, continuity of care, geographical proximity/accessibility, and similar gender/religion. All these determine the patronage pattern. This study did not lay emphasis on the importance of catchment population/density in location decisions and therefore population was not considered as a relevant location parameter. It also did not suggest the possible reason for the dichotomy/differential in the location of health facility in the study area.

On location of medical facilities, numerous factors of public facilities have been given. Reid [1984] observed that in recent times, the issues of access, equity and efficiency criteria that consider the distributional aspect of public facilities have been receiving attention. Singh and Kaish, (2013) shares the same idea when he asserted that accessibility questions had assumed greater importance among researchers and policy makers in recent years, implying that, location on a transport network is an important determinant of the availability of public facilities (medical services inclusive). Looking at the geo spatial distribution of primary health care, Sowton (1991) using Germain GPS to capture the Co-ordinates of the health centres with the aid of Arc Map 9.3 (ESRI) GIS software applied multivariate technique to show that the nearest neighbour value for Warri South Local Government, Nigeria, was clustered in pattern of distribution while Ughelli South LGA showed randomised distribution rather than clustered pattern. Guagliardo (2004) in their web-based spatial approach to the distribution of health care facilities observed that the distribution of Information System in Nigeria showed that stakeholders were able to visualize the distribution of tertiary hospitals in Nigeria, and make useful inferential decisions with ease.

All these reviewed studies have not been done at the southeast region of Nigeria rather in the western area which has quite different cultural, social and morphological uniqueness than those the south east region of Nigerian geographical setting. Hence, the findings in these already studied areas do not suffice in the southeast area of Nigeria emerging city. Thus, the essence of this study

### 3. Methods and Procedures

The research designs that was adopted in the study were survey design and geo-referencing method. Data was collected from both secondary and primary sources. Three Local Government Areas (LGAs) constituting the study area - Enugu North, Enugu South and Enugu East were used in the study. The choice of the areas was due some factors which include: political status, relative centrality, population concentration, commercial activities, and physical development. 15 neighbourhoods were chosen out of the 21 neighborhoods in the study area. Clustered, systematic and simple random sampling techniques were used to proportionately select the respondents to be used in the study. The study area was clustered according to the administrative designation of the areas. The Williams (1978) sample size determination formula as was adopted by Kerlinger and Lee (2000) was used in the study and a sample size of 1300 was determined. This formula is given as:

$$S = \frac{n}{1 + n/N}$$

Where

S = the sample size

n = the proportion of population that was sampled (0.1 percent)

N = the total number of people/population of three selected LGAs.

The 1300 sample size was consequently equitably distributed according to the clustered LGAs as follows: Enugu North – 504; Enugu South – 377; and Enugu East – 419. The 1,300 copies of questionnaire were distributed randomly but proportionately to the sampled households in the 15 urban areas in the selected three LGAs. The reason for distributing questionnaire to all the identified urban areas according to size of population is to ensure regularity and equal

representation of the contribution of all the areas in the study. The centroid of each urban area formed basis for the assessment of that area.

Data were also gathered through Ground – Truthing Observations (GTOs). They include the geo-location of the PHCF in Enugu urban using Global Positioning System (GPS), ARC GIS version 9.2 and Goggle Earth. All these werer used to collect the coordinates of the Primary Health Care Centers using Global Position System (Germin 76 model GPS), Hand-held type and post field-work. The scanned map was be first geo - referenced, then, on screen digitized and computer image processing applied, using vector graphic techniques afforded by ArcView GIS 3.2a release. The list of healthcare centers and their addresses in the Enugu urban areas and Geo–Eye Image of Enugu urban as shown in table 1 were also sourced from google earth. The administrative map of Enugu urban served as the base map. GPS Device was used to collect coordinate points of the health centers in the three local governments. The administrative map of Enugu ubran was scanned and geo-referenced to WGS UTM ZONE 31. Healthcare facilities was digitized as point features and converted to Database format and these spatial data was organized in different layers.

### Primary health centers with their co ordinates

1. ABAKPA HEALTH CENTER..... 6° 28' 47.40" N, 7° 31' 00.11" E
2. GRA EAST HEALTH CENTER..... 6° 27'39.58" N, 7°29'53.49" E
3. GRA WEST HEALTH CENTER.....6°27'22.76" N, 7°29'18.23" E
4. INDEPENDENCES LAYOUT.....6°25'47.65" N, 7°31'06.82" E
5. INLAND TOWN.....6°26'31.40" N, 7°29'52.86" E
6. NEW HAVEN HEALTH CENTER.....6°27'20.13" N, 7°31'30.13" E
7. NEW HAVEN WEST HEALTH CENTER.....6°27'28.88" N, 7°30'51.67" E
8. COAL CAMP HEALTH CENTER.....6°25'59.84" N, 7°28'55.05" E
9. OGUI NIKE HEALTH CENTER.....6°25'59.84" N, 7°30'05.12" E
10. UMUNEVO HEALTH CENTER.....6°26'25.92" N, 7°30'11.63" E
11. AFIA NINE HEALTH CENTER..... 6°26'15.59" N, 7°30'17.09" E
12. UGBOZEJI HEALTH CENTER..... .6°29'32.66" N, 7°31'20.01" E
13. AMORJI NIKE HEALTH CENTER..... 6°31'10.45" N, 7°31'31.00" E
14. FEDERAL HOUSING..... .6°28'38.49" N, 7°30'15.52" E
15. HARMONY HEALTH CENTER..... 6°24'50.26" N, 7°29'41.35" E
16. AMOKPO HEALTH CENTER..... 6°30'58.73" N, 7°30'18.13" E
17. ALULU HEALTH CENTER..... 6°30'10.51" N, 7°30'49.72" E
18. UGWOGO NIKE.....6°37'36.45" N, 7°33'28.70" E
19. ACHARA 1 HOSPITAL..... 6°26'34.37" N, 7°29'51.56" E
20. UGBO OWA..... 6°28'47.16" N, 7°29'09.22" E
21. ASATA HEALTH CENTER.....6°26'44.18" N, 7°30'01.45" E
22. AKWUKE HEALTH CENTER ----- 6°26'22.68" N, 7°30'09.05" E
23. ONUORIE HOSPITAL----- 6°25'10.42" N,7°31'04.57" E
24. OBEAGU HEALTH CENTER -----6°25'10.46" N, 7°31'03.33" E
25. UWANI CENTRAL-----6°25'01.11" N, 7°30'54.65" E
26. NEW GARKI----- 6°23'24.32" N, 7°30'03.92" E



27. SATA HOSPITAL -----	6°26'43.60" N, 7°30'01.40" E
28. EVANGEL HOSPITAL -----	6°19'51.18" N, 7°31'41.91" E
29. UWANI HEALTH CENTER.....	6°25'48.06" N, 7°29'30.22" E
30. NDIAGU AMECHI.....	6°24'41.39" N, 7°31'45.74" E
31. AMECHI HEALTH CENTER.....	6°25'02.87" N, 7°29'53.51" E
32. OBEAGU/AMECHI.....	6°08'32.09" N, 7°26'07.11" E
33. UGWUAJI.....	6°24'29.29" N, 7°33'07.41" E
34. OBINAGU IJI HOSPITAL.....	6°17'23.92" N, 7°24'00.48" E
35. ACHARA 2 HOSPITAL-----	6°25'26.37" N, 7°29'56.68" E

The Nearest Neighbour Analysis was also used in this study to determine the nature of spatial distribution of PHCF in the three LGAs in Enugu urban. GIS tools was used to test the spatial distribution pattern of existing primary health care facilities in Enugu Urban areas and to consider its equitability in distribution. Buffer analysis was also applied to define the proximity and accessibility of health care facilities in Enugu metropolis to the users.

#### 4. Data Presentation Analysis

##### 4.1 Household that patronize PHCF

Households that patronize PHCF was also examined in the survey. 74.2% of the respondents patronize PHCF while 25.8% of the respondents do not patronize PHCF in the neighborhood meaning they seek medical attention from other sources. These other sources include patent medicine dealer, traditional medicine and self-medication. This result indicates that majority of the household patronize PHCF in the study area. The households that use PHCF were the respondents that were then used for the study.

##### 4.2 Average Distance from Residence to Closet PHCF

The average distance from respondents' residence to PHCF range from less than a kilometer to above 5 kilometers in the study area. The average distance to get to the closet PHCF was also examined. The breakdown of the data collected as presented in table 2 indicates that 7.6% of the respondents get to the PHCF in less than 1km before being able to secure medical treatment from the PHCF, 17.3% of the respondents get to the PHCF within 1km – 1.5km, 27.2% of the respondents get to the PHCF within 1.6km – 2km, 20.5% of the respondents get to the PHCF within 2km – 3km , 14.9% of the respondents get to the PHCF between 3.1km – 4km, 11.1% of the respondents get to the PHCF between 4.5km – 5km and 6.4% of the respondents get to the PHCF above 5km. This indicates that majority of the PHCF are not above 1km away from the neighborhood. The analysis of this result shows that most of these PHCF are more than 2 kilometers away from neighbourhoods.

**Table 2 Average Distance from Residence to Closet PHCF**

Average Distance	Response	Percentage
Less than 1km	69	7.6
1km – 1.5km	156	17.3
1.6km – 2.0km	201	27.2
2km – 3km	185	20.5
3.1km – 4km	135	14.9
Between 4.5km – 5km	100	11.1
Above 5km	58	6.4
<b>Total</b>	<b>904</b>	<b>100</b>

Source: Researchers' survey, 2023

#### 4.3 Means of Access

The study assessed the means of accessing the health facility in the neighborhood in the study area. The result as presented in table 3 shows that 31.9% of the respondents access the health facility by trekking, 0.6% of the respondents access the health facility by bicycle, 0.3% of the respondents access the health facility by motorcycle, 40.6% of the respondents access the health facility by tricycle and 26.7% of the respondents access the health facility by motor vehicle. Hence, the data indicates that tricycle and motor vehicle were found to be the major means of accessing the PHCF in the neighborhood.

**Table 3: Means of Accessibility**

Accessibility	Response	Percentage
By trekking	288	31.9
By bicycle	5	0.6
By motorcycle	3	0.3
By tricycle	367	40.6
By motor vehicle	241	26.7
<b>Total</b>	<b>904</b>	<b>100</b>

Source: Researchers' survey, 2023

#### 4.4 : Average Walking Time to PHCF in the Neighborhood

The average walking time to secure medical treatment from the PHCF in the neighborhood was also examined, the data collected as shown in table 4 reveals that 18.6% of the respondents walk to PHCF within 5 – 10mins, 27.9% of the respondents walk to PHCF within 11 – 15mins, 23.3% of the respondents walk to PHCF within 16 – 20mins, 12.7% of the respondents walk to PHCF within 21 – 25mins and 17.5% of the respondents walk to PHCF above 25mins (17.5%). This indicates that majority of the respondents walk to PHCF within 11 – 15mins.

**Table 4: Average Walking Time to PHCF in the Neighborhood**

Average Walking Time	Response	Percentage
5 – 10mins	168	18.6
11 – 15mins	252	27.9
16 – 20mins	211	23.3
21 – 25mins	115	12.7
Above 25mins	158	17.5
<b>Total</b>	<b>904</b>	<b>100</b>

Source: Researcher’s survey, 2023

#### 4.5 Population and Number of Primary Health Care Facilities in Enugu Urban

The study considered the population of the various neighbourhoods in the study area and the number of Primary Health Care Facilities in Enugu Urban. This is crucial since population is a cardinal variable in the siting of any PHCF. This is presented in Table 5

**Table 5 Population and Number of Primary Health Care Facilities in Enugu Urban**

S/N	LOCATION	*No of PHCF	**POPULATION
<b>ENUGU NORTH</b>			
1	IVA VALLEY	1	21,662
2	OGUI NEW/L	3	100,468
3	INDEP/ LAYOUT	1	24,452
4	ASATA	3	53,181
5	NEW HAVEN	2	45,680
6	OGBETE	3	63,331
7	G.R.A	2	47,754
<b>TOTAL</b>		<b>15</b>	<b>356,528</b>
<b>ENUGU SOUTH</b>			
1	AWKUNANAW	1	32,748
2	UWANI	3	77,660
3	ACHARA L/O	3	122,422
4	MARYLAND	1	11,368
	OBIAGU	2	13,368
		<b>10</b>	<b>257,566</b>
<b>ENUGU EAST</b>			
1	ABAKPA	6	220,781

2	EMENE	1	108,495
3	TRANS EKULU	1	27,935
<b>TOTAL</b>		<b>8</b>	<b>357,211</b>

Source: \*Internal Revenue, Enugu South Local Government Area, 2023  
 \*\* Estimated from National Population Census, (2006)

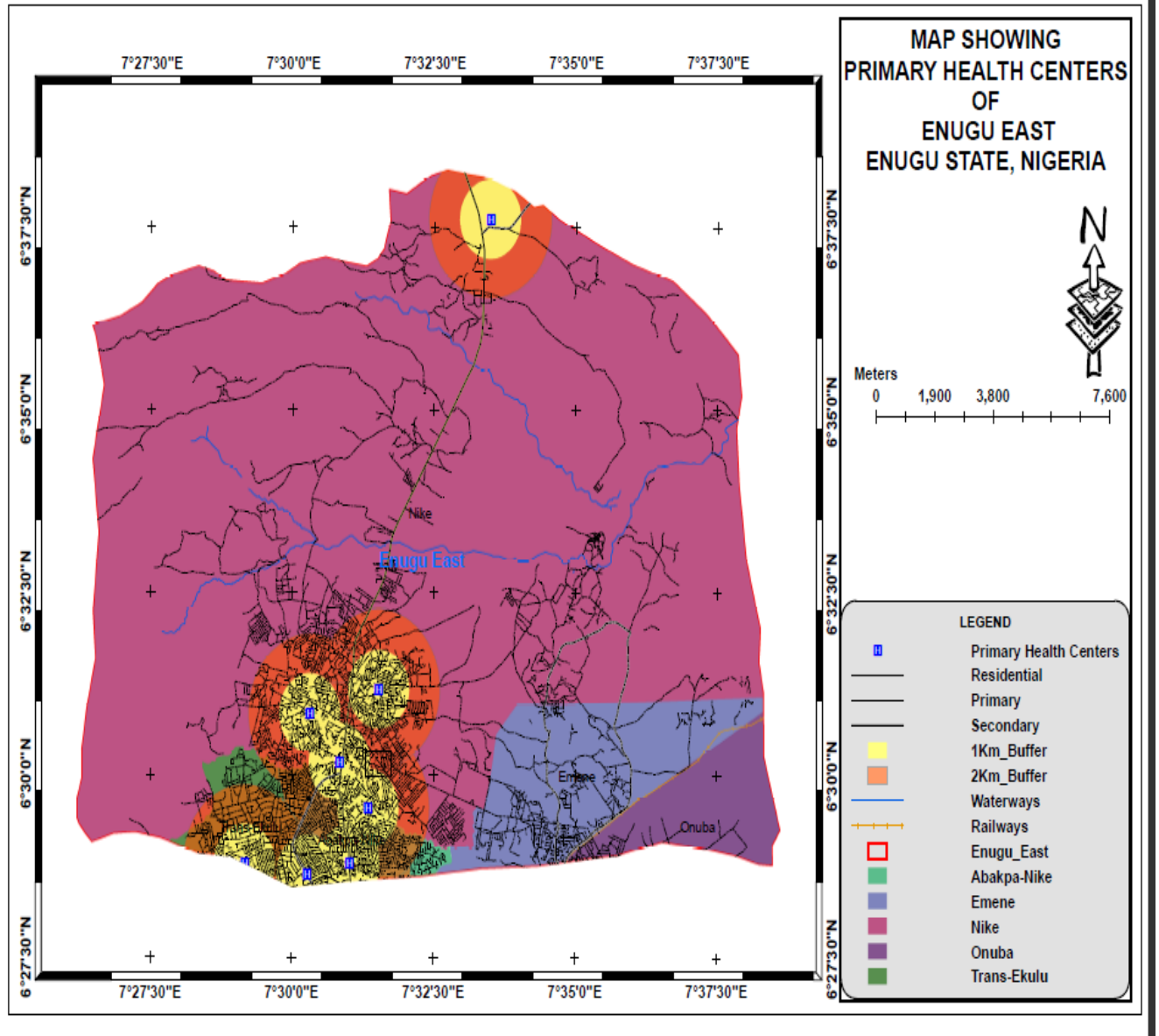


Figure 1. Map showing the GIS of the PHCF in Enugu East Local Government Area

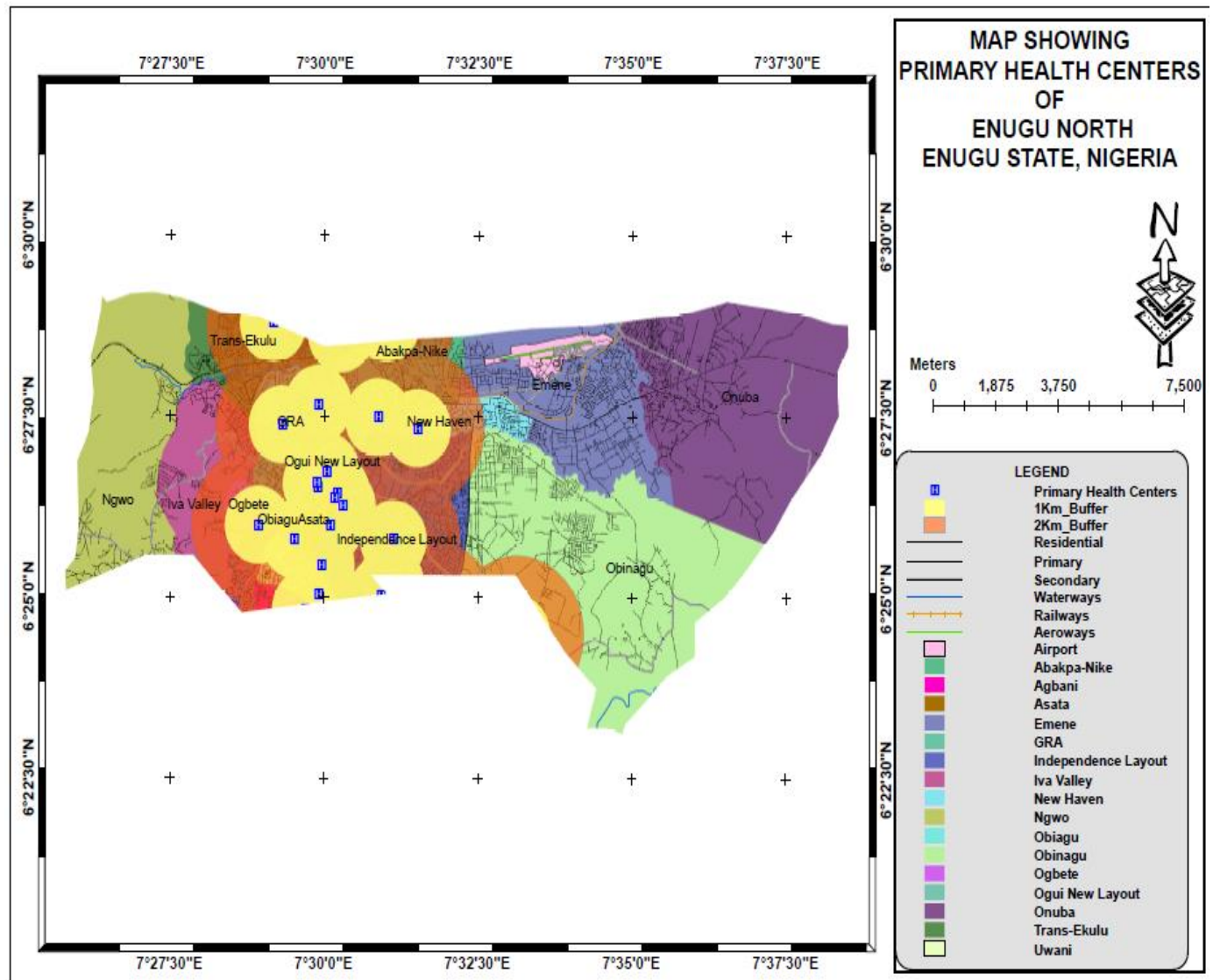


Figure 2. Map showing the GIS of the PHCF in Enugu North LGA



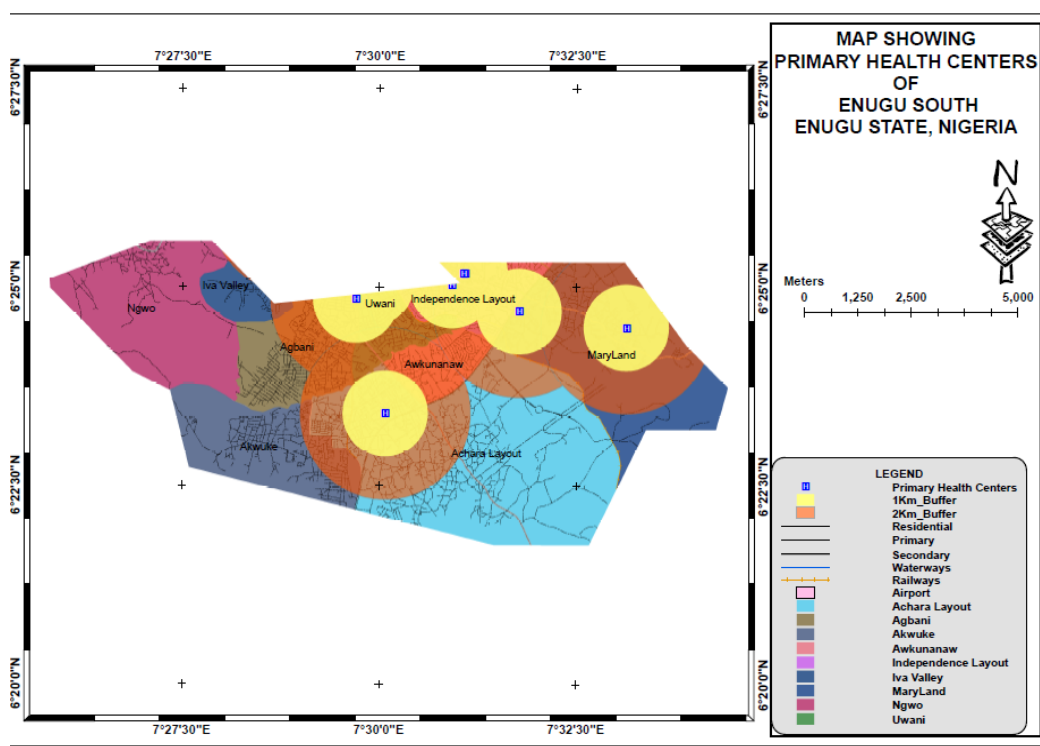


Figure 3. Map showing the GIS of the PHCF in Enugu South LGA

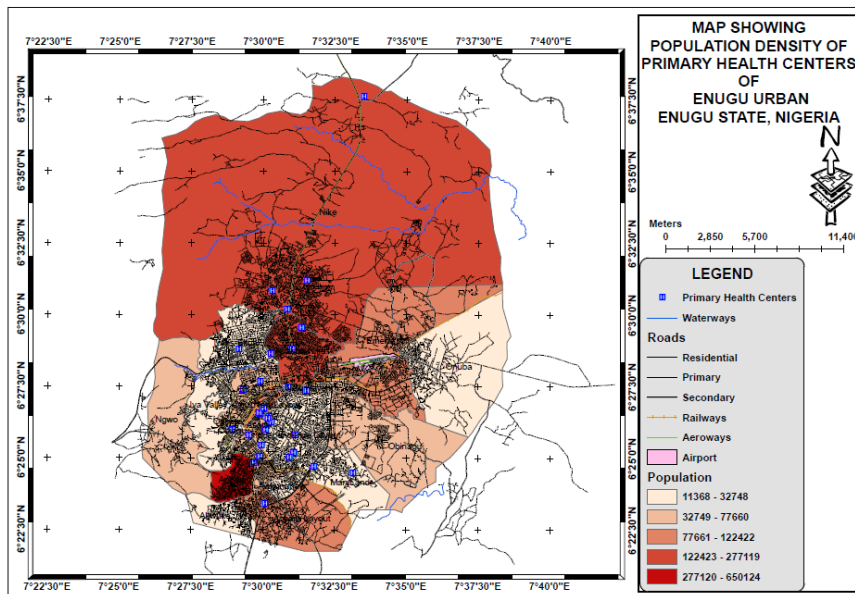


Figure 4. Map showing the GIS of the PHCF in Enugu and the population density

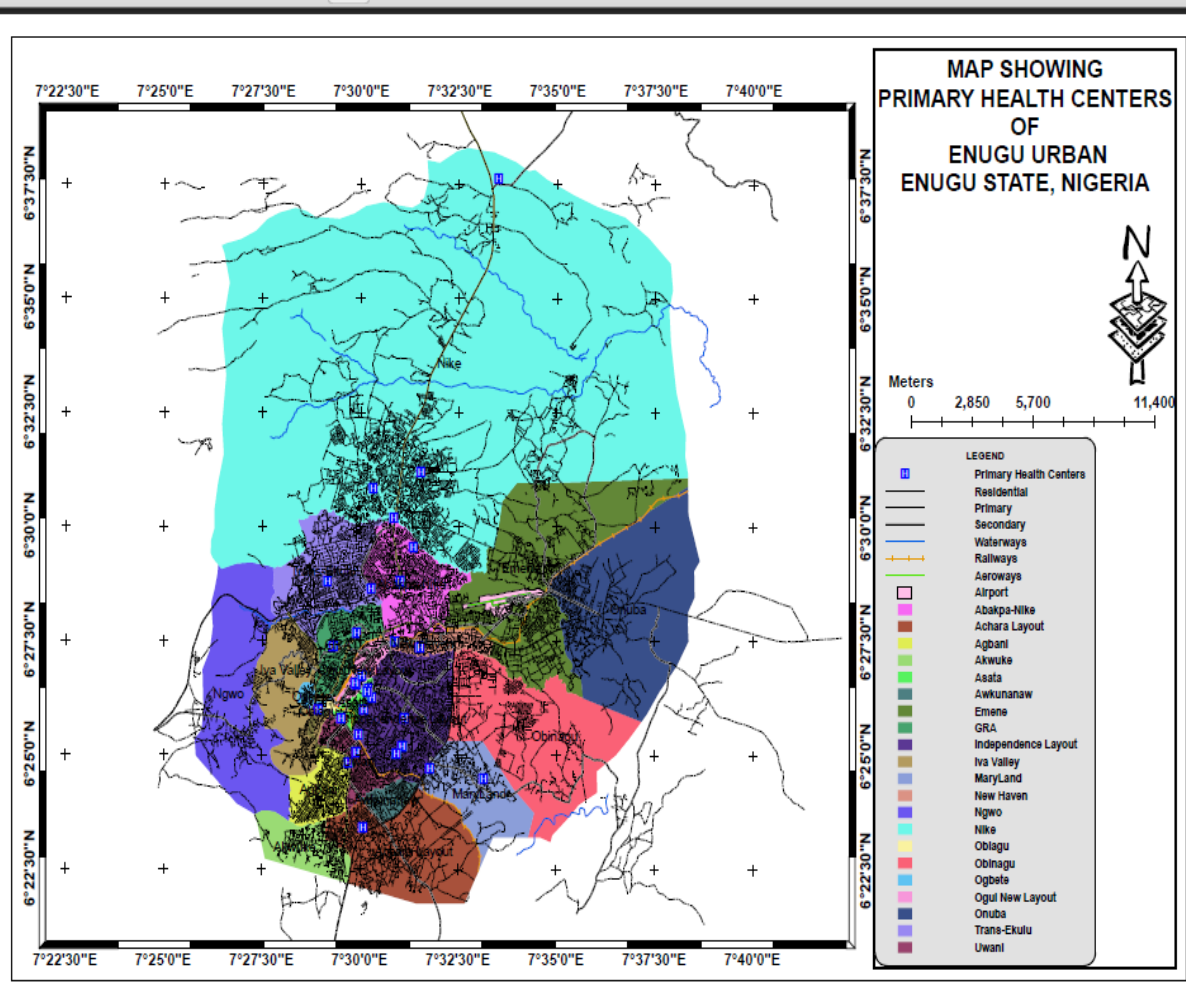


Figure 5. Map showing the GIS of the PHCF and its Locations

## 5. Results

The study presented the results from the GIS maps as seen in figures 1 to figure 5. The results suggest from the GIS maps as seen in the figures above that the spatial distribution of existing primary health care facilities in Enugu Urban areas was not equitably distributed. Furthermore, the Nearest Neighbour Analysis ( $R_n$ ) results which show the spatial/nature of distribution of PHCF (crowfly distance) in Enugu North, Enugu East and Enugu South Local Government Areas reveals as presented in table 6

**Table 6 . The result of NNA in the distribution of Primary health care facilities**

	<b>LGA</b>	<b>Observed mean distance</b>	<b>Expected mean distance</b>	<b>Nearest neighbour index (Rn)</b>	<b>Z-score</b>	<b>P-value</b>
1	Enugu North	964.29	5313.2	0.0714	3.8355	0.000125
2	Enugu East	23602.3	11317.4	0.0655	3.9952	0.000322
3	Enugu South	5243.89	8502.43	0.0867	1.6344	0.101122

Source: Nearest Neighbour Analysis Result, 2023

It was determined from the study that the Nearest Neighbour Index (Rn) results for Enugu North, Enugu East and Enugu South LGAs were 0.071, 0.065 and 0.086 respectively. This result implies that they these public health facilities in Enugu urban were not equitably distributed since these balues are less than 1.

Buffer analysis was applied to define the proximity and accessibility of health care facilities in Enugu metropolis to the users. Buffers were created around all of the facilities in the study area by using the Municipal planning standard with a radius of 1 kilometre in the catchment area of the health care facilities. This therefore showed that accessibility of the existing primary health care facilities in Enugu Urban area to the population was patterned. The study showed that most residents live more than 1km away. This was depicted in figures 1, figures 2 and figure 3. This implies that many residents need to trek for a long time before getting to the PHCFs

## 6. Discussion

The study, which showed the access to a spatial and location GIS information, provided a unique platform to identify and measure distribution of health care facilities in Enugu metropolis, which would help the planners to make better quicker decisions with cost much less than all other methods, and it will make the health care facilities database more reliable, and data can be retrieved for analysis at any time. The most important result of this study was the bad distribution of health services, which led to the difficulty to manage these services. As there are areas in Enugu urban which have health care services and others do not have. It was revealed with the aid of the GIS techniques to the geographical distribution of this PHCF that they are clustered irregularly and serves few citizens and this resulted that there are no balance between the administrations of the services. The planners and decision makers should consider the obtained results to achieve fair and better distribution of public services. The result on GIS Maps show that the distribution of health care facilities in the area was clustered. This corroborates with the Nearest Neighbourhood analysis result. It was observed that the clustering was most in Enugu East with the Rn of 0.0655. This could be attributed to the presences of many PHCF in some areas like Abakpa Nike that has not less than 5 PHCFs. Again, Enugu North experienced also a cluster distribution with Rn 0.0714. However, Enugu South which also depicts cluster distribution although not as the other LGAs had Rn of 0.0867. It was tilting towards random distribution which statistically starts from 0.09. This implies a high level of inequity in the facilities' distribution. It also had an important implication

for facility planning and management. The inequity implied that neighbourhoods at the core like Abakpa Nike, Obiagu, uwani etc enjoyed closer proximity to the location of medical facilities while other settlements were at farther proximities away from the facilities. In the area where population is not evenly distributed, the mean centre of population distribution is calculated as the “demand”, which forms the origin of location. The facility location point is considered as destination points or “supply”. In other words, it was discovered that that the pattern of distribution of PHCF in the metropolis is generally clustered and uneven, and as one moves away from the center, the sparser the PHCF become. Neighborhood analysis of the areas gives values less than 0.09, as such, ascertains the clustering in the distribution of the PHCF in the metropolis. Furthermore, the clustering distribution of PHCF in the study area revealed that the existing distribution was not patterned by any policy guideline. Accordingly, most areas in Enugu Urban have inadequate distribution of PHCF. The result of the spatial distribution of PHCF in Enugu metropolis shows an uneven distribution of PHCF in the metropolis. Findings from this study also shows this distribution and revealed that the concentration of the PHCF in the central part of the area. The concentration of the PHCF within the central area cannot be explained by the Christellars central place theory, which explains that, the location of services is base on seize of community, population, accessibility and proximity, putting into consideration, threshold and range.

In this study also, the buffer analysis was applied to define the proximity and accessibility to health care facilities in Enugu metropolis. Buffers were created around all of the facilities in the study area by using the Municipal planning standard with a radius of 1 kilometre in the catchment area of the health care facilities. There is no standard distance for citing Primary health care centres in most countries of the world.(Singh and Kaish, 2013). The distance of 1000 meters (1km) and 2000 meters (2km) radius were, however, used in the study to analyse the accessibility to PHCFs. (see Figure s1-3). This shows that one has to travel more than a km before reaching a health centres. The result shows that almost some of the areas of the metropolis are underserved, considering 1km buffer. Areas that are outside the city centres – Emene, Awunanaw, etc were not fully served, considering the both 1km and 2 km buffer. Unlike the study the study done by Abdurrahman and Usul , (2013) where they noted that most of the cities in Yola, Nigeria were PHCF were located were accessible to the demanding population. The results show that some areas in Enugu urban are located outside of the 1 kilometre accessibility zones, especially in the western and northern parts of Enugu Metropolis. In addition, it is clear that the existing health care centres must serve a catchment area that is larger than the standard size. Based on this output, different parts of Enugu metropolis were determined to have low health care accessibility. (Luo, 2004); Guagliardo, 2004). Health care planners can use this model to make decisions regarding where to build new health centres in Enugu metropolis. For example, areas beyond the 1,000 m accessibility zones can be used as a reference for determining potential locations for additional health care centres in Enugu metropolis.

## **7. Contribution to Knowledge**

Considering the advantages of GIS relative to traditional analysis methods, the two major contributions of this study is to demonstrate that spatial GIS information can be used to reach desired quality decisions in a short time frame and at a low cost. In other words, GIS will enable

the establishment of a health care facility database, which can be easily retrieved and analysed at any time. The study actually demonstrated that access to spatial GIS information and analysis will help planners make better decisions quicker and at a lower cost than required for the traditional methods and enable the establishment of a health care facilities database that can easily be retrieved for analysis at any time.

## 8. Conclusion

This study explored the use of GIS for modeling the spatial distribution and accessibility of the health care delivery system in Enugu Metropolis. It was revealed that Primary healthcare facilities have been provided but not equally distributed and not readily accessible. Healthcare planning is a challenging field that depends on spatial data such as location and characteristics of health center demand. GIS was used to analyze the center catchment as well as study of the spatial distribution of the PHC in the area. The study concluded that the existing health facilities is not marching the available demand because most of these facilities were clustered within the radius of the city centre and on the other hand area the periphery were neglected. It could be said that there is inequality in the distribution of primary healthcare in Enugu metropolis. The developed map indicates the uneven distribution of health facilities

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