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Spatial Analysis of Spatio-Physical Accessibility to Rural Healthcare Facilities in Nangere Local Government Area of Yobe State, Nigeria

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ABSTRACT: *The paper aimed to examine the spatio-physical accessibility to rural healthcare facilities in Nangere Local Government Area of Yobe State. The research was conducted using stratified random sampling. The Data was collected using a structured questionnaire and Global positioning system (GPS). The questionnaires were administered by means of face-to-face method of data collection. The GPS (Garmin 76CSx) was used to record the coordinates of the health facilities and 146 villages. The geospatial data was analyzed in ArcGIS 10.8 version's environment. The questionnaires were processed using SPSS 22.0 software. The study findings revealed that the majority of the respondent's walks on foot to access health facility in their area. The physical usability was determined using the spider diagram algorithm and multiple ring buffer technique. The minimum distance between the settlements and the nearest facility in each ward was 0.107 kilometers, while the maximum distance was 12.829 kilometers.*

KEYWORDS: Nangere, spider diagram, spatial, healthcare

INTRODUCTION

Having access to health care facilities when required is a basic human right. It is desirable for a government to ensure that all people have fair and convenient access to basic health care services of high quality. Spatial differences in accessibility to health care facilities are often caused by the spatial distribution of the population, health care facilities, and transportation infrastructure in a region, resulting in deprived areas and communities having poor spatial accessibility to required health care facilities. Access to health care services by local communities in a defined geographical area is adequate, equitable, and convenient is a critical issue of human service provision to the people who live there. It's also a difficult problem for policymakers (Luo & Wang, 2003; Burns & Inglis, 2007) and urban planners (Geertman & Ritsema, 1995; Hewko, 2001).

Healthcare is an important indicator of social growth. Access to services is an integral part of the overall healthcare system, and it has a significant effect on the disease burden that plagues many developed countries' health conditions. Therefore, measuring access to healthcare facilities contributes to a wider understanding of health systems' performance within and between countries and facilitates the development of evidence-based health policies (Mainardi, 2007). It is a fundamental human right to have access to health care services when needed. A government should ensure the high-quality

provision and equal and easy access to fundamental health care services to all citizens. Varying spatial distribution of the population, health care facilities, and transportation infrastructure in an area often lead to spatial variations inaccessibility to health care facilities, which in turn will result in disadvantaged locations and communities having poor spatial accessibility to needed health care facilities.

In many health care systems, adequate, equitable, and easy access to health care facilities is often considered one of the main objectives (Powell & Exworthy, 2003). To ensure equal and easy access it is essential to ensure that the population, health care facilities, and the transportation infrastructure are positioned in a manner that facilitates high spatial accessibility. Accessibility to healthcare is the ability of a population to obtain a specified set of health care services. In this context, geographic accessibility is often referred to as spatial or physical accessibility (Halden et al., 2000). Physical accessibility addresses the complex relationship between the distribution of the population and the supply of healthcare facilities (Black et al., 2004). A health care facility is defined as all units owned by the public and private authorities as well as voluntary organizations and which provide health care services, hospitals, and health and maternity centers. Consequently, Onokerhoraye (1999) defined a health care facility as all units owned by the public and private authorities as well as voluntary organizations and which provide health care services including hospitals, health, and maternity centers.

A healthy population and access to healthcare services are significant factors influencing economic development and prosperity. Thus, accessibility to healthcare facilities has generally been identified as a major indicator of development, and the existing spatial pattern of distribution of healthcare facilities play a very prominent role in gauging the level of efficiency or otherwise of the existing level of provision of these facilities within any region (Sanni, 2010). Accessibility to health care is a multi-dimensional concept and can be defined as the ability of a population to access healthcare services. It varies across space because neither health professionals nor residents are uniformly distributed (Wang, 2011).

Many people in Nigeria encounter a range of service delivery and health problems when they try to access healthcare, such problems range from drug stock-out to poor infection prevention practices to shortage of health staff and this can lead to unnecessary suffering by patients or in the worst cases, death. In Yobe State, like in every other State in Nigeria, the general hospitals which are avenues for healthcare delivery are mostly located in the local government headquarters, very far away from many rural areas and usually inaccessible to some settlements within the LGA. It is interesting to note that most people in Nangere Local Government live in scattered farmsteads, hamlets, and village settlements. Most of these local communities are cut off from the basic service centers by lack of good roads or transport facilities especially in the rainy season as most of the roads are paved roads. Considering the landmass of Nangere Local Government which is (980km^2.) and its dynamic population with an ever-increasing demand for health care services; it is important to analyze their physical accessibility to meet the demand of the growing population.

LITERATURE

Spatial Pattern and Accessibility to Health Care Facilities

A number of studies have attempted to determine the spatial accessibility to Health Care facilities in various communities. Prominent among such investigators are Bindu and Janak (2013) these researcher's used a geospatial approach to assess and model the spatial accessibility of primary Health Care facilities in the tribal Talukas of the Vadodara District of Gujarat State of India. Findings showed that, the locational pattern of the PHC in the study area was randomly dispersed as obtained by Average Nearest Neighbor analysis and all such PHCs are overburdened, serving large population as per the norms, where 8 PHCs were serving total population of more than 22,000 which goes up to 51,000.In terms of the time and distance, findings also convey that, the central and southern villages of the study area were relatively accessible as compared to the eastern and northern villages. The analysis suggest that the population of the study area can optimally be accommodated by allocating only a few new facility but emphasis has to be given to improving the connectivity especially in the inaccessible area which are rendered as dark zone on the basis of poor road connectivity.

Murad (2004) created a GIS-Based spatial profile for exploring health services supply and demand in Jeddah city, Saudi Arabia. Level of accessibility was identified using accessibility indicators scores. Also a demand based catchment area was created to define the growth and extent of health catchment area. The outputs of his application provides health planners with spatial tools for evaluating the location of health services supply and demand and considered as a spatial decision support system for health planners in the city.

Adetunji (2013) examined the spatial distribution pattern and accessibility of urban population to Health Care facilities in Ilesa Southwestern Nigeria. The findings revealed that Health Care facilities were unevenly distributed. Health trips in Ilesa were therefore skewed towards zones with more health services. The result of the analysis of variance (ANOVA) further showed significant variations in accessibility to the facilities among the sampled population in the area. It was concluded and recommended that some of the public health care facilities in the area should be upgraded to the status of General Hospitals due to the growing nature of the town.

Michael (2011) assessed the spatial distribution of health care facilities in Lokoja, Kogi State of Nigeria. The study was conducted within five (5) neighborhoods in the study area. "Nearest Neighbor Analysis" (NNA) was applied in analyzing the data to establish the distribution pattern of health centers in the study area. An indication of weak randomness was observed, which is indicative of insignificant accessibility.

Abdurrahman and Nurünnisa (2013) analyzed the spatial accessibility of health care facilities in Yola, Adamawa state, Nigeria. Models of accessibility were built based on distance to Health Care facility in the state. Density of health facilities and Physicians were considered as well as health facility to population ratio. The model was tested

using ArcGIS raster calculator operation. The result shows gross in-adequacy both in terms of Physicians and distance to health care facilities.

Sanni (2010) examined the distribution of Health Care facilities in the thirty local government areas of Osun State, Nigeria. Twelve indices, representing the totality of Health Care delivery by State and local governments in the state were used for the analysis. Findings indicated existence of gaps in access to Health Care facilities between local government areas in the state, though the observed gap could not easily be attributed to rural-urban dichotomy. The study concluded that there was an urgent need for serious intervention on the part of the government in the provision of Health Care facilities in the state, focused on equitable distribution and accessibility to enhance regional development.

However, a number of studies have utilized Network and Neighborhood analyses within the ArcGIS software environment to analyze pattern and physical accessibility to Health Care in various parts of the world. A good example is found in the work of Brabyn and Skelly (2002), the study utilized Cost Path Analysis Network Spatial Analyst Tool to estimate the geographical accessibility of Public Hospitals in New Zealand via a road network. In this case, minimum Travel Time and distance to the closest Hospital were determined.

Ejiagha et al. (2012), employed network analysis to determine the closeness of a facility and shortest route to the Health Care facilities in Enugu Urban Area of south eastern Nigeria. The study also identified areas deprived of healthcare facility within the GIS software environment. Furthermore, Muhammad et al., (2015) employed both Network and Neighborhood GIS analyst tools to analyze the spatial distribution and accessibility to Health Care facilities in Giwa and Tofa LGAs of Nigeria. OD (Origin Destination) matrix was created and the average nearest neighborhood analysis was done. Findings showed that healthcare facilities are grossly inadequate, their distribution is random. Also some people travel a distance of up to 30km to access the nearest healthcare facility.

Spider-diagrams (Desire-lines)

In GIS a set of points representing population settlements can be assigned a variable corresponding to each point's distance from its linked facility (nearest or otherwise defined). The linkage can be mapped visually using Spider-diagrams, at the center of each "spider" is a point representing a health facility, while the "legs" represent the shortest distance from the facility to its linked settlements, visualization approaches which have been enhanced by GIS include spider-graph approaches showing linkages between patient and service as a series of straight lines (Bullen and Moon, 1994). These diagrams are useful visual tools as it is easy to identify long lines which represent settlements with low access. Spider diagram is a diagram generated by drawing lines connecting points in one layer to their linked points in another layer. These diagrams resemble spiders because the lines radiate out of a central point. The method is also known as "desire-line analysis". Some studies have shown that one of the main factors

that determines how likely an eligible individual is to utilize a health service is their geographic proximity to a health facility (Al-Taiar et al. 2010, Yao et al. 2012).

Therefore, a potential indicator for health service accessibility could be the distance in a straight-line between a population settlement and a linked health facility. It is often convenient to define this linkage in terms of distance, so that a settlement is linked to whichever health facility is nearest to it in a straight line. This technique also appeared to be useful and powerful in determining physical accessibility to facilities, particularly in an area where there are no road networks to carry out network-based spatial analysis. However, linkage can be defined in other ways. For example, if in a survey, a respondent has specified a particular health facility as one that they actually utilize, and then the linkage can be defined based on reported actual usage, even though this will mean that not all the population is linked to their geographically closest facility (Noor et al. 2003). Spider line Diagram also known as desire lines, are series of lines drawn from each facility location (PHC) to Demand Points (Village Centroid). They can be either un-weighted or weighted. Spider lines show Village Connectivity with the nearest facility location i.e. PHC's. A line is drawn from each PHC to its nearest Village Centroid, making it easy to see the actual area of influence of PHC (Divya, 2014). Desire line shows the behavior of the people, they always prefer to go to the nearest facility point, rather than the facility point located relatively far away from villages.

METHODOLOGY

The Study Area

The Nangere Local Government Area is located in Yobe State in Nigeria's North-East geopolitical region, with its headquarters in Sabon Garin Nangere. It's bordered on the north by Jakusko Local Government, on the east by Fune Local Government, on the west by the Dambam Local Government area of Bauchi state, on the south by Potiskum Local Government, and on the south/east by Fika Local Government. The population of the Local Government area is estimated to be 119,694 people, spread out over 980 km^2 (NPC, 2021). Nangere Local Government is situated between 11°51'50" and 12°00'00" north latitude and 10°50'00" and 11°04'11" east longitude of the Meridian. In Nangere Local Government, there are approximately 416 villages. The study area has a total of eleven (11) geopolitical wards namely: Degubi, Langawa/Darin, Nangere, Pakarau, Tikau, Watinani, Chukuriwa, Dawasa, Dazigau, and Chilariye wards (INEC, 2019).

Method of Data Collection

The study was carried out using stratified random sampling; five (5) settlements were randomly selected from each of the 11political wards of the study area. Structured questionnaire and was used for data collection. The questionnaires were administered using the face-to-face method of data collection, as it is recommended to be the superior and reliable method for data collection. A total of fifty-five (55) questionnaires were used and administered to each of the selected settlements in the study area. The GPS (Garmin 76CSx) was used to record the geographic locations of the health facilities and 146 communities across the eleven (11) political ward of Nangere Local Government.

Method of Data Processing and Analysis

The questionnaires were sorted, coded, and processed using SPSS 22.0 software. The administrative map of the study area was scanned and imported into ArcGIS 10.8 version software for geo-referencing. The geo-referenced map was digitized on-screen under the following themes: the political ward as polygon, LGA boundary as lines to depict the extent of the study area. The questionnaire data in this research was analyzed using descriptive statistics in SPSS 20.1 software, for physical accessibility of health care facilities (HCFs) from the surrounding settlements within each of the political wards, Spider graph tool of MapInfo was used to create desire-lines to connect the PHCC and the population settlements in the area, the polyline as a layer or the spider-diagram represents or stands for the direct routes from settlements to PHCC facility are created, this layer contained the distance field in its attribute table and this is required for the analysis. This technique was alternatively deemed fit because the area under study is typically a semi-urban locale that has no proper networks of tarred roads which preferably be used to apply network analysis to determine the physical accessibility of the HCFs from each of the settlement.

Spider diagram or desire-line have been traditionally used to study healthcare and other social facilities accessibility particularly in data poverty region, the coordinates of villages in the various political ward were exported from excel, multiple ring buffers of 1000m, 2000m, 3000m, 4000m, and 5000m were created over each of the PHCC in the study area as depicted. This choice was decided based on the benchmark standards of the World Health Organization (WHO, 1997), which ruled out 5km as mean accessibility, the varying spatial accessibility of the population settlements to the available PHCC of each ward was then determined using spatial and attributes query using structured query language known as structured query language (SQL) function tool of ArcGIS 10.8. The data from questionnaires administered were analyzed using SPSS 22.0 software and display the results as frequency and percentage.

RESULTS/FINDINGS

Physical accessibility to rural health care facilities in Nangere Local Government Area using the questionnaires administered and analyzed using SPSS 22.0 software.
Which transportation mode did you use to reach Healthcare Facility?

Table 1. Means of Transportation to Healthcare Facility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Walking on foot	20	36.4	36.4	36.4
	Pushcart	2	3.6	3.6	40.0
	Animal cart	17	30.9	30.9	70.9
	Keke-Napep (Tricycle)	11	20.0	20.0	90.9
	Car	5	9.1	9.1	100.0
	Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The survey revealed that out of the total respondent's 20 (36.4%) walks on foot to healthcare facility, 2 (3.6%) use pushcart as their means of transport to the healthcare facility, 17 (30.9%) use an animal cart as means of transport, 11 (20%) use Keke Napep (Tricycle) as means of transport and 5 (9.1%) use the car as their means of transport to the health facility. .

Do you encounter difficulty in accessing healthcare facility in your area?

Table 2. Difficulty in accessing healthcare facility

	Frequency	Percent	Valid Percent	Cumulative Percent
ValidYes	39	70.9	70.9	70.9
No	16	29.1	29.1	100.0
Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The survey revealed that 39 (70.9%) agreed that they encounter difficulty in accessing health facilities in their area while 16 (29.1%) did not agree that they encounter difficulty in accessing health facilities.

Do you have healthcare facility in your village?

Table 3. Healthcare facility in villages

	Frequency	Percent	Valid Percent	Cumulative Percent
ValidYes	20	36.4	36.4	36.4
No	35	63.6	63.6	100.0
Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The survey revealed that 20 (36.4%) agreed that they have a healthcare facility in their village while 35 (63.6%) did not agree that they have a healthcare facility in their village.

Does seasonal condition (raining or dry season) affect your accessibility to healthcare facility

Table 4. Effect of seasonal condition in accessing health care facility

	Frequency	Percent	Valid Percent	Cumulative Percent
ValidYes	42	76.4	76.4	76.4
No	13	23.6	23.6	100.0
Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The table revealed how seasonal conditions (raining or dry season) affect your accessibility to the healthcare facility, 42 (76.4%) agreed that seasonal condition affects their accessibility to health facility while 13 (23.6%) did not agree that seasonal condition affects their access to the health facility.

How much is the cost of transportation to access healthcare facility in your area

Table 5. Transportation cost to access healthcare facility

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 10-50	12	21.8	21.8	21.8
50-100	18	32.7	32.7	54.5
100-150	17	30.9	30.9	85.5
Above 150	8	14.5	14.5	100.0
Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The survey revealed the cost of transportation to access healthcare facility in the study area, 12 (21.8%) spent 10 to 50 as transportation cost, 18 (32.7%) spent 50 to 100 as transportation cost, 17 (30.9%) spent 100 to 150 as transportation cost to access health facility and 8 (14.5%) spent above 150 as transportation cost to access health facility from their various settlement.

How much distance did you travel to reach healthcare facility?

Table 6. Distance to nearest healthcare facility

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Below 1km	7	12.7	12.7	12.7
1-5km	11	20.0	20.0	32.7
5-10km	11	20.0	20.0	52.7
Above 10km	26	47.3	47.3	100.0
Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The table revealed the distance to the nearest healthcare facility, 7 (12.7%) of the respondents cover below 1km to access health facility, while 11 (20%) cover 5km to 10km to access health facility and 26 (47.3%) cover above 10km to access health facility.

How much time did it take to reach healthcare facility?

Table 7. Travel time to reach the nearest healthcare facility

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Below 5 minutes	4	7.3	7.3	7.3
5-10 minutes	11	20.0	20.0	27.3
10-15 minutes	6	10.9	10.9	38.2
15-20 minutes	14	25.5	25.5	63.6
Above 20 minutes	20	36.4	36.4	100.0
Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The table revealed travel time by road transport system to the nearest healthcare facility, 4 (7.3%) travel below 5 minutes to access health facility, 11 (20%) travel for 5 to 10

minutes to access health facility, 6 (10.9%) travel for 10 to 15 minutes to access health facility, 14 (25.5%) travel for 15 to 20 minutes to access health facility and 20 (36.4%) travel above 20 minutes to access health facility.

What is nature of road from your village to the healthcare facility?

Table 8. Nature of road to the nearest facility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Good	9	16.4	16.4	16.4
	Good	9	16.4	16.4	32.7
	Fair	13	23.6	23.6	56.4
	Poor	24	43.6	43.6	100.0
	Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The survey revealed the nature of the road to the healthcare facility in the study area, 9 (16.4%) out of the total respondent rate the nature of the road as very good and good while 13 (23.6%) rate as fair, and 24 (43.6%) rate the nature of the road as poor.

How is your accessibility to healthcare facility from your village?

Table 9. Accessibility to healthcare facility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Good	3	5.5	5.5	5.5
	Good	13	23.6	23.6	29.1
	Fair	11	20.0	20.0	49.1
	Poor	28	50.9	50.9	100.0
	Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The table revealed the accessibility to healthcare facility in the study area, 3 (5.5%) rate the accessibility as very good, 13 (23.6%) rate as good, while 11 (20%) rate as fair, and 28 (50.9%) rate the accessibility to the health facility in the study area as poor.

Does healthcare facility in your area have adequate staff and equipment?

Table 10. Adequate staff and equipment in healthcare facility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	3	5.5	5.5	5.5
	Agree	15	27.3	27.3	32.7
	Disagree	26	47.3	47.3	80.0
	Strongly disagree	8	14.5	14.5	94.5
	Neither agrees nor disagrees	3	5.5	5.5	100.0
	Total	55	100.0	100.0	

Source: Author's Analysis, 2021

The table revealed that 3 (5.5%) out of the total respondents strongly agreed that the health facilities have adequate staffs and equipment's, 15 (27.3%) agreed, 26 (47.3%) disagreed, while 8 (14.5%) strongly disagreed, and 3 (5.5%) neither agrees nor disagrees that the facilities have adequate staffs and equipment.

Spatio-physical analysis of physical accessibility to rural health care facilities in Nangere Local Government Area was determined spatially using spider diagram algorithm in ArcGIS 10.8 software interface. Spatio-physical physical accessibility analysis using spider graph map (Desire Lines) physical accessibility analysis rest upon the spatial relationship between the centers of settlement and health care facilities, the linkage is mapped visually using Spider-diagrams, at the center of each "spider" is a point representing a health facility, while the "legs" represent the shortest distance from the facility to its linked settlements. These diagrams are useful visual tools as it is easy to identify long lines which represent settlements with low access.

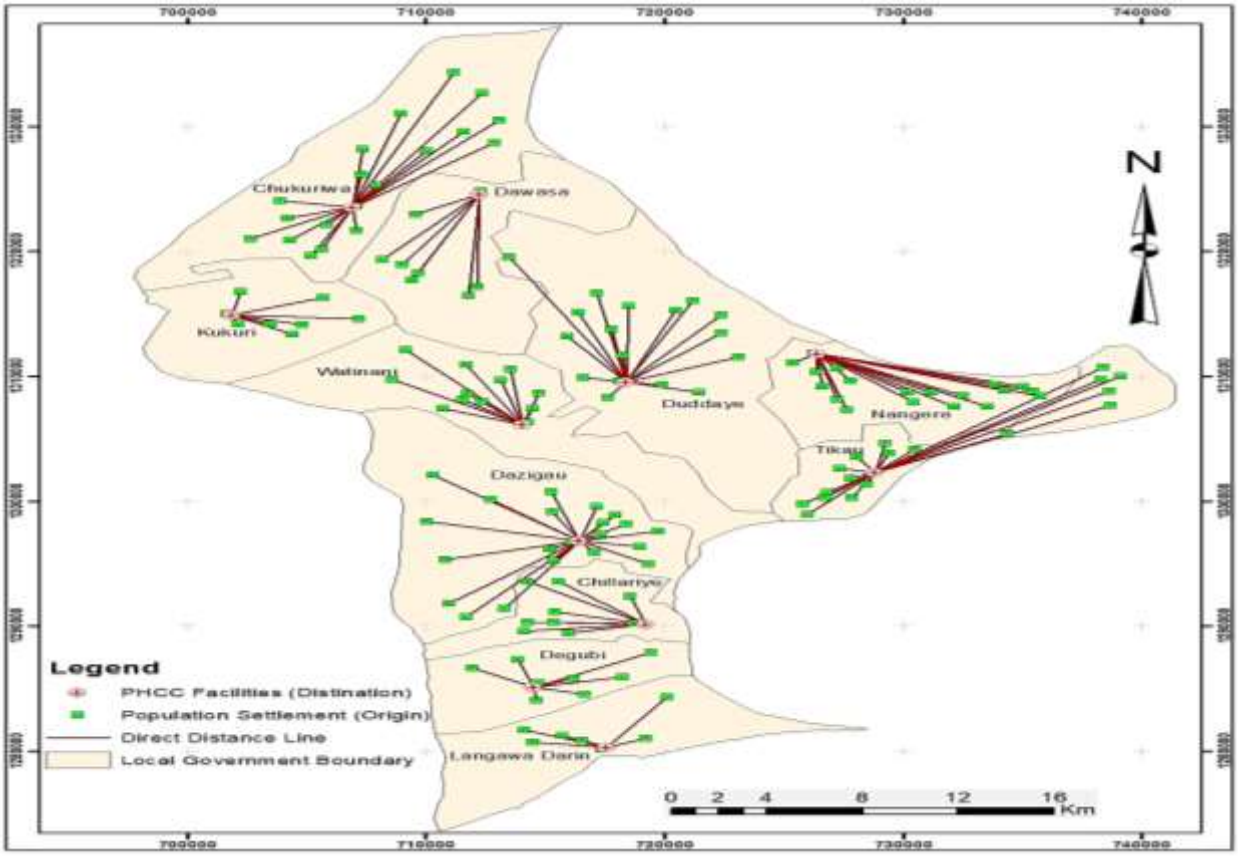

Figure 1. Spider Graph Map
Source: Author's Analysis, 2021

Table 11: Minimum, Maximum, and Average Distance to the Nearest Facilities

Query (m)	Minimum distance to the nearest facilities (m)	Minimum Distance to the nearest facilities (km)	Maximum distance to the nearest facilities (m)	Maximum distance to the nearest facilities (km)	Average distance to the nearest facilities (m)	Average distance to the nearest facilities (km)	Count
1000 Buffer	107	0.107	975	0.975	372.462	0.372	13
2000 Buffer	1015	1.015	1990	1.990	1547.640	1.548	25
3000 Buffer	2095	2.095	2984	2.984	2521.591	2.522	22
4000 Buffer	3025	3.025	3980	3.980	3505.476	3.505	21
5000 Buffer	4081	4.081	4961	4.961	4562.786	4.563	14
Above 5000 Buffer	5117	5.117	12829	12.829	7709.078	7.709	51

Source: Author's Analysis, 2021

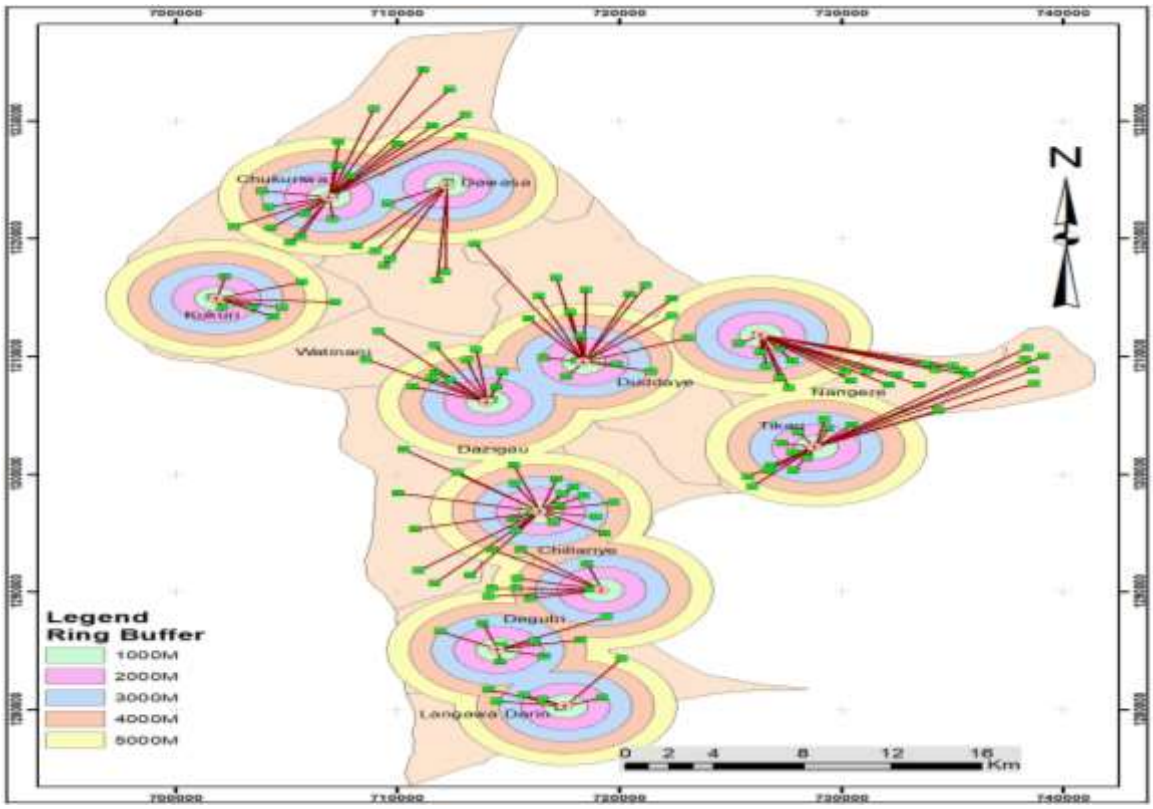

Figure 2: Population settlement within 1000m, 2000m to 5000m radius of the PHCC
Source: Author's Analysis, 2021

DISCUSSION

Table 1 revealed that the majority of the respondent's walks on foot to access health facility in their area; this is because the area lack means of transportation as government ban the use of the motorcycle which is the major means of transportation in the area. The people in the study area encounter difficulty concerning means of transportation as most of the settlements a located far from the major roads linking to urban area. Table 2 revealed that the majority of the respondents (70.9%) agreed that they encounter difficulty in accessing health facilities. This may be attributed to the problems with transportation from their settlements to the health facility. Table 3 findings revealed that the majority of the respondents (63.6%) did not agree that they have a healthcare facility in their village; this is true because the study area has about 416 villages which make it impossible for each village to have a facility in their villages. Table 4 revealed that the majority of the respondents agreed that seasonal condition affects their accessibility to a health facility; this is because during the raining season they find it difficult to access health facility because of nature of the road leading to the facilities. Table 5 revealed that the majority of the respondents spent 50 to 100 as transportation fees to access at least a facility from their villages. Table 6 revealed that the majority of the respondents travel for more than 10km to access health facilities. Table 7 revealed that the majority of the respondents travel above 20 minutes to access health facilities; this may be attributed to the nature of public transport and road network in the area. Table 8 revealed that the majority of the respondents rate the nature of the road as poor; this is because there is no good road network in the area. Table 9 findings revealed that the majority of the respondents rate their accessibility to a health facility as poor. Table 10 revealed that the majority of the respondent disagreed that the facilities did not have adequate staff and equipment's; this may be attributed to the remoteness of the area.

The spider diagram algorithm showing the accessibility of HealthCare facilities in the area as shown in figure 1, however, the distance variable was exported to a spreadsheet and analyzed using non-spatial analysis techniques. It could be seen from Figure 1 the various PHCC across the entire 11 geopolitical wards serve as the center of the spider while the legs represent the shortest distance from the facility to its linked settlements, the results obtained helped in identifying the areas that are easily accessible in terms of healthcare facilities within the standard distance recommended by WHO using ring buffer analysis. According to WHO (1997), healthcare facilities should not be more than 5km from residential areas and should be of distance not more than 20m from the major road. Multiple ring buffer zones of 1000m, 2000m, 3000, 4000m, 5000m, and above 5000m were built around all the PHCC to identify the settlements that fall within the buffer's build.

Buffer analysis is used for identifying areas surrounding geographic features is also used to show the served and un-served area for PHC‟s in the study area. It has been used to identify the villages within a given buffer limit of the facility. Euclidean buffer is drawn around each PHC. The villages of a ward can be easily determined whether they are served or un-served. A village within the buffer was considered to have access to a facility, while those outside the buffer were assumed not to have access. SQL

function of 'select statement' was used to mine-out the population settlements that spatially falls within each of the buffers, and the outputs of these queries result-sets were used to calculate the minimum and maximum distance of each of population settlement to the PHCC of each ward from the exported queried tables.

From table 11 it's clear that the minimum distance to the nearest facilities in 1000m buffer query was 107m (0.107km), the maximum distance to the nearest facilities was 975m (0.975km), the average distance to the nearest facilities was 372.462m (0.372km) and the count was 13 villages. The minimum distance to the nearest facilities in the 2000m buffer query was 1015m (1.015km), the maximum distance to the nearest facilities was 1990m (1.990km), the average distance was 1547.640m (1.548km) and the count was 25 villages. The minimum distance to the nearest facilities in the 3000m buffer query was 2095m (2.095km), the maximum distance to the nearest facilities was 2984m (2.984km), the average distance was 2521.591m (2.522km) and the count was 22 villages. The minimum distance to the nearest facilities in the 4000m buffer query was 3025m (3.025km), the maximum distance to the nearest facilities was 3980m (3.980km), the average distance was 3505.476m (3.505km) and the count was 21 villages.

The minimum distance to the nearest facilities in the 5000m buffer query was 4081m (4.081km), the maximum distance to the nearest facilities was 4961m (4.961km), the average distance was 4562.786m (4.563km) and the count was 14 villages. The minimum distance to the nearest facilities above 5000m buffer query was 5117m (5.117km), the maximum distance to the nearest facilities was 12829m (12.829km), the average distance was 7709.078m (7.709km) and the count was 51 villages, this indicates how the distance of health facilities affect access and utilization of the facilities a significant association exists between utilization of the health facilities and distance traveled to reach a facility, the above table shows the minimum, maximum, and averages of the 146 villages across the 11 political ward of Nangere Local Government Area.

Six queries were run to identify areas that are not within WHO range, the queries include 1000m buffer query, 2000m buffer query, 3000m buffer query, 4000m buffer query, 5000m buffer query, and above 5000m buffer query in each political ward to check the accessibility of the residents. Areas outside the 5000m buffer zone indicate areas that find difficulty in accessing the healthcare facility which also connotes that the facilities are not adequate for the population. The straight-line distances from the settlement to the healthcare facilities were obtained from the query result which was then subjected to non-spatial analysis to obtain the minimum, maximum, average, and count. The results in Table 13 show the query, the minimum, the maximum, the count, and the average distances covered along the straight line to access the nearest healthcare facilities. Figure 2 shows the 1000m, 2000m, 3000m, 4000m, and 5000m radius buffer and the settlements that are within the WHO standard of 5000m (5km) distance to access healthcare facility.

Implication to Research

Health is paramount to the well-being of man, its availability and accessibility are equally important hence the need to have an overview of the accessibility of healthcare facilities that influence its utilization in a particular area. This research will be beneficial to policymakers, the ministry of health, researchers and professional bodies, and Non-governmental organizations. This information may form the basis for effective management and policy guide on health care issues in the study area, effective management of health care delivery system in Yobe state and Nangere local government area in particular. It will also provide a platform to review existing policies on the issue of healthcare distribution.

CONCLUSIONS

This study investigated spatial accessibility to health care facilities in Nangere LGA and developed a GIS-based approach to the identification of disadvantaged villages in terms of spatial accessibility to health care facilities. Through the investigation, this study established that within the Nangere LGA there exist spatial variations in the distribution of healthcare facilities. The study findings concluded that the majority of the respondent's walks on foot to access health facility in their area; this is because the area lack means of transportation as government ban the use of the motorcycle which is the major means of transportation in the area. The people in the study area encounter difficulty concerning means of transportation as most of the settlements a located far from the major roads linking to urban areas. The study also concluded that the majority of the respondents did not agree that they have healthcare facility in their village, this is true because the study area has about 416 village which makes it impossible for each village to have a facility in their villages, and the majority of the respondents travel for more than 10km to access health facility.

There were 416 villages within the study area, and 370 of them have no health care facilities available. A large proportion of the villages have to travel a long way to access the health care facilities. Most villages' accessibility to health care facilities is very poor, as public transport is both inadequate and infrequent due to inadequate and low frequent availability of the public transportation services. In Nangere LGA, health care facilities were distributed in such a way that only a small proportion of the population can access those facilities by walking. A large proportion of the population resides beyond 10km of travel distance or 15 to 20 minutes of driving time to nearest health care facilities. However, spatial accessibility may be poor for residents live in areas in absence of adequate transportation services even when the travel distance is only a few kilometers. The study recommended that the improvement of overall access to health care facilities in the Nangere LGA can be achieved by either improving the public transportation system or re-allocating health care facilities according to the spatial and needs of the resident population.

Future Research

The following areas are recommended for further research: The Socio-economic impact of accessibility to Health Care Facilities in Nangere LGA, Analysis of Health Care

Delivery System in Nangere LGA and A Spatial perspective to the distribution of health care facilities and health personnel in Nangere LGA

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