International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 4, May-June 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Geospatial Mapping of Health Facilities in Nangere Local Government Area of Yobe State, Nigeria

Ibrahim Abubakar Audu[1], Tijjani Bukar Lawan[2]

[1]Department of Environmental and Resource Management,
Usmanu Danfodiyo University Sokoto, Sokoto State, Nigeria
[2]Department of Geography, Yobe State University, Damaturu, Yobe State, Nigeria

ABSTRACT

This paper is aimed at mapping healthcare facilities in the Nangere Local Government Area of Yobe State. Geospatial mapping of health care facilities was achieved by taking the geographic coordinates of all the healthcare facilities in the Local Government using the Global Positioning System Garmin GPS map 76CS receiver. The data were analyzed using ArcGIS 10.8 version software. The study identified primary and secondary health care facilities without any tertiary health care facility and also without a single private hospital or clinic across the entire eleven (11) political wards of Nangere Local Government Area. The findings revealed that 46 healthcare facilities were distributed across the eleven (11) political wards in the Local Government Area. The primary health care facilities (PHC) constituted 98 % (45) while the secondary Health Care facilities (SHC) constituted 2 % (1). The average nearest neighbor summary for the study area shows the significant level and the critical level that indicates a random distribution pattern of health care facilities in the area, however, it was unevenly distributed given the concentration of health care facilities in Dazigau, Degubi, Darin, Pakarau, and Tikau while other wards were inadequately served. However, both the primary and secondary health care facilities were government-owned, the study concluded that there were inequalities in the spatial distribution of health care facilities in the Nangere Local Government Area of Yobe state, thus this disparity in the distribution of health facilities has generated different accessibility level to health care facilities in the LGA, it, therefore, recommends that; Government and the private organization should provide health care facilities in the wards that do not have enough health care facilities. This will further improve access to Health Care facilities in the study area.

How to cite this paper: Ibrahim Abubakar Audu | Tijjani Bukar Lawan "Geospatial Mapping of Health Facilities in Nangere Local Government Area of Yobe State, Nigeria" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-4, June 2021, pp.1217-1223, URL: www.ijtsrd.com/papers/ijtsrd42527.pdf

IJTSRD42527

KEYWORDS: *GIS, Mapping, Healthcare Facilities, GPS*

INTRODUCTION

Digital mapping has now become a critical method for addre ssing a wide range of environmental issues. The technique used for producing digital maps is dependent on the level of details required, the use to which the map will be put, and the sourced data. Digital mapping operations help organizations achieve important analytical and operational advantage. Location intelligence is enabling even non-Geographic Information Systems (GIS) specialists to gain the advantage of using location to make more insightful everyday decisions. The capability of GIS to handle data from specific geographic locations, and the ability to gather, store, manipulate, analyze and visualize geo-referenced data offers the opportunity to create a realistic perspective of the world and a chance to see the future action (Burrough, 2001). This exceptional ability provides scientists, engineers, surveyors, planners, and resource managers the opportunity to distill and combine large sets of spatial data into useful information offering a new perspective and fresh approaches to problem-solving. The GIS is used in almost every aspect of our daily lives, from earth science and other physical sciences to finance and management. Thus, the data it uses also vary, ranging from remote sensing, Global Positioning Systems (GPS), conventional data collected by in situ instruments and questionnaires, etc.

These data that are either time series or spatial can be used to show the spatial context of numerous fields and the creation of models and forecasts of future occurrences. Geospatial analysis and environmental health began to interact with each other due to developments in computing. The utility of this is in the ability to view maps and identify areas of prevalent diseases, pest breeding grounds, spatial population distribution for health studies, doctor-to-patient ratio, and location of health facilities. For hazards ranging from soil lead to particulates in the air, to disease-carrying mosquitoes, researchers have used geospatial analysis to examine where hazards exist in the environment and to model their spatial distributions (Glass et al., 1995). Initial GIS applications in environmental health include analysis of spatial clustering of childhood leukemia concerning nuclear facilities in England (Openshaw et al., 1988), a study that laid the groundwork for the extensive body of research on GIS-based analysis of spatial disease clusters. Other early studies include (McMaster, 1988) GIS assessment of community vulnerability to hazardous materials and (Wartenberg,

1992) and (Wartenberg et al., 1993) use of GIS to characterize populations living near high-voltage transmission lines.

The geospatial analysis tool, the GIS has been used in vector-borne disease studies to determine the associations between environmental features and vector concentrations (e.g. Glass et al., 1995). From many recent studies, GIS was used to map out vector-borne and zoonotic diseases such as Lyme disease, viral meningitis, Hantavirus, Dengue Fever, Yellow Fever, and rabies, among others, and their spatial distribution. Ghosh (2001) used GIS to analyze the association of urban environment features that facilitated viral activities of West Nile Virus (WNV) and compared the spatial association between WNV infected mosquito pools and human cases with heterogeneous urban characteristics in Minnesota USA between 2002 and 2007. His results showed that WNV is considerably higher in areas close to swamps, parks, and water discharge sites. Optimized the accuracy of the applications of larvicides at mosquito breeding sites in Dar-es-Salam Tanzania using GIS, they employed community-based development of sketch maps of the target areas that are termed participatory GIS and then involved a procedure of verifying the sketched maps using laminated aerial photographs in the field that are later analyzed and digitized in a GIS system.

The level of details acquired assisted the government not only in malaria monitoring but in the implementation of council programs and spatially explicit analysis for research and evaluation purposes. GIS has also been applied to depict mobile hazards associated with, for example, traffic flows and transportation of hazardous wastes (Lovett et al., 2006). Advances in geospatial technologies and space-time methods have greatly enhanced our ability to model and monitor the spatial distributions and flows of environmental hazards. Geospatial techniques have also been used to identify at-risk populations (maps) exposed to radioactive iodine and lead poisoning (Wartenberg, 1992). There are three important functions of Geographical Information System (GIS) in health research and policy analysis: spatial database management, visualization and mapping, and spatial analysis (Cromley&McLafferty, 2002). WHO (1997) specified criteria for health care planning for third world countries and indicated that each service area should cover a 4km2 catchment area with a population of 60,000 for primary health care to have adequate and equity of access to health centers. In line with WHO (1997), this study, therefore, aimed to map the spatial distribution of health care centers in Nangere LGA of Yobe State using GIS techniques. This aim was achieved by identifying, mapping both public and private health centers in the study area. The provision of health care centers in Nigeria is a concurrent responsibility of the three tiers of government that include Local, State, and Federal Government institutions.

The Local Government is the least administrative unit, in addition to this; private investors in healthcare delivery are also visible. The Primary HealthCare (PHC) Department is one of the five departments of each of the 774 Local Government areas in the country that is charged with the duty of ensuring that healthcare services are delivered in their areas on an integrated and affordable basis. Location mapping however is critical in reaching out to the people within their respective areas of jurisdiction. The ability to locate health facilities and identify their capabilities in terms of services and hours of operation has been underscored due to a lack of proper mapping facilities. Unlike in the developed world where all health facilities are of equal standard, in the developing world, it is different. Abbas et al., (2012) examined the spatial distribution of Healthcare facilities in the Chikun local government area of Kaduna State Nigeria by using GIS and GPS to map exiting ones, evaluate adequacy based on World Health Organization standard and propose new ones. However, their results neither show how queries could be made to show both spatial and attribute information from a database nor provide a visual map portraying details of health facilities. Here, we provide spatial distribution of healthcare facilities, and a single visual map of the health facilities, and the inventory of existing healthcare facilities.

The Study Area

Nangere Local Government is located between latitudes 11°51'50'' and 12°00'00'' North of the Equator and between longitudes 10°50'00'' and 11°04'11'' East of the Meridian. The Nangere Local Government area situated in Yobe state, North-East geopolitical zone of Nigeria and has its headquarters in the town of SabonGariNangere. The local government area has an projected population of 119,694 persons spread over a geographical area of 980 km^2 (Natinal Population Commission, 2021). The study area has a total of eleven (11) electoral wards namely: Langawa, Nangere, Pakarau, Tikau,Chilariye, Chukuriwa, Dawasa, Dazigau, Degubi, and Watinani wards (INEC, 2019). It is bounded by the following local government areas; to the north by Jakusko, to the east Fune, to the west Dambam Local Government Area of Bauchi state, to the south Potiskum, to the south/east Fika.

METHODOLOGY

Method of Data Collection

A checklist was used to acquire the attribute data of identified healthcare facilities, the data include the name of health care facility, political ward, category of healthcare e.g. dispensary, clinic, health post, etc., and other relevant information such as ownership i.e. public or private, year of establishment, was used for the creation of health care facility inventory for the study. The GPS (Garmin 76CSx) was used to obtain the geographic locations of the health facilities.

Method of Data Processing

The administrative map of the study area was scanned and imported into ArcGIS 10.8 version software for geo-referencing. Geo-referencing allows the researchers to relate a space object or raster object that has not been tied to any geographic reference to a coordinate reference system. The geo-referenced map was digitized on-screen under the following themes: the Local Government Area and the political ward as polygon, LGA, and ward boundary as lines to portray the extent of the study area.

Method of Data Analysis

ArcGIS 10.8 version software was used for data analysis, the GPS coordinates were imported into ArcGIS 10.8 interface, all the shape files holding the relevant data layers were then spatially overlaid to create a combination of visual map of polygon, line, and point feature classes. Consequently, the x and y spontaneously displayed the geo-referenced location of each HCF in space, along with political wards as reflected in their attribute tables, this aid to visualize the distribution of all the types of HCFs in the study area. The Average Nearest Neighbor Statistics (ANNS) inferential statistical tool

in ArcGIS10.8 was used to investigate the spatial pattern in the data. The Kernel Density tool calculates the density of features in a neighborhood around those features. This tool automatically calculates for the LGA the average nearest neighbor ratio by dividing the observed average distance by the expected average distance.

RESULTS AND DISCUSSIONS

The result of the data set for the identified healthcare facilities in the study area is displayed in Table 1, Table 2, and Figure 1. The Tables and Figures show both inventories, numerical and spatial distribution of the categories of health care facilities in the study area. An inventory of all existing healthcare facilities in the Nangere Local Government Area is shown in table 1 below. The inventory displays the name of the facility, political ward, and types of facility, ownership, and year of establishment, latitude, and longitude of each health care facility in the study area.

Table 1: Inventories of Existing Health Care Facilities

No	Name of Facility	Ward	Categories of HCF	Ownership	Year	Latitude	Longitude
1	GarinMuzam HP	Chillariye	Health Post	Public	2013	11°41.054'	11°00.057'
2	Chillariye PHCC	Chillariye	Primary Health Care Center	Public	2003	11°41.957'	10°59.436'
3	Dagare PHCC	Darin	Primary Health Care Center	Public	2004	11°36.023'	11°01.099'
4	Darin HP	Darin	Health Post	Public	2007	11°34.617'	10°56.555'
5	DorawaDadi HP	Darin	Health Post	Public	2009	11°33.062'	10°59.324'
6	Fadawa HP	Darin	Health Post	Public	2008	11°34.497'	11°00.397
7	Challino PHC	Degubi	Primary Health Care	Public	1997	11°38.538'	10°56.905'
8	Gabur HP	Degubi	Health Post	Public	2005	11°36.809'	10°56.800'
9	Gwasko HP	Degubi	Health Post	Public	2013	11°38.315'	10°57.756'
10	Mbela HP	Degubi	Health Post	Public	2003	11°36.952'	10°59.323'
11	Degubi PHCC	Degubi	Primary Health Care Center	Public	2002	11°38.794'	10°59.246'
12	Dazigau PHCC	Dazigau	Primary Health Care Center	Public	2003	11°43.438'	10°59.671'
13	Gudi PHC	Dazigau	Primary Health Clinic	Public	2009	11°45.353'	10°57.936'
14	Gabarun HP	Dazigau	Health Post	Public	2003	11°46.622'	10°55.751'
15	GarinShera D	Dazigau	Dispensary	Public	2001	11°39.792'	10°55.750'
16	Yaru HP	Dazigau	Health Post	Public	1986	11°40.842'	10°56.352'
17	Tudun Wada HC	Tikau	Health Clinic	Public	2006	11°51.540'	11°11.555'
18	Dagazurwa PHC	Tikau	Primary Health Clinic	Public	1997	11°49.431'	11°12.305'
19	Dagaretikau HP	Tikau	Health Post	Public	1996	11°49.231'	11°11.032
20	Tikau PHCC	Tikau	Primary Health Care Center	Public	1947	11°46.249'	11°05.160'
21	Kael HP	Tikau	Health Post	Public	1999	11°47.679'	11°07.560'
22	Old Nangere HC	Nangere	Health Clinic	Public	1995	11°51.840'	11°04.167'
23	SabonGari PHCC	Nangere	Primary Health Care Center	Public	1999	11°50.921	11°04.492'
24	Nangere GH	Nangere	General Hospital	Public	2007	11°51.402'	11°04.457'
25	GarinJata HC	Nangere	Health Clinic	Public	1997	11°8.3665'	11°13.286'
26	BaranIya HC	Watinani	Health Clinic	Public	2004	11°8.7927'	10°9.6776'
27	Dugum HC	Watinani	Health Clinic	Public	2000	11°8.3948'	10°9.5593'
28	GarinGanbo DP	Watinani	Dispensary	Public	1985	11°8.5249'	10°9.0211'
29	Watinani PHCC	Watinani	Primary Health Care Center	Public	2017	11°7.5891'	11°01.042'
30	GarinKadai HC	Kukuri	Health Clinic	Public	2004	11°55.463'	10°51.846'
31	Kukuri PHCC	Kukuri	Primary Health Care Center	Public	1959	11°8.8711'	10°8.5293'
32	Kukuri PHC	Kukuri	Primary Health Clinic	Public	2011	11°8.8778'	10°8.5606'
33	Haram DP	Kukuri	Dispensary	Public	2011	11°54.351'	10°55.647'
34	Chukuriwa PHCC	Chukuriwa	Primary Health Care Center	Public	1999	11°56.989'	10°52.763'
35	Dadiso HP	Chukuriwa	Health Post	Public	2012	11°56.376'	10°50.490'
36	Gada HP	Chukuriwa	Health Post	Public	2000	12°08.693'	10°9.3291'
37	Bagaldi DP	Dawasa	Dispensary	Public	2002	11°8.8395'	10°9.45261'
38	Dawasa PHCC	Dawasa	Primary Health Care Center	Public	2004	11°7.084'	11°04.748'
39	Dawasa PHC	Dawasa	Primary Health Clinic	Public	2004	11°7.0172'	11°04.751'
40	Garin Baba DP	Dawasa	Dispensary	Public	1959	11°69.247'	11°03.337'
41	Biriri HC	Pakarau	Health Clinic	Public	1999	11°9.4627'	11°01.665'
42	Duddaye PHCC	Pakarau	Primary Health Care Center	Public	1999	11°8.0367'	10°9.9579'
43	Garin Keri PHC	Pakarau	Primary Health Clinic	Public	1974	11°8.7049'	10°9.8586'
44	Katsira HC	Pakarau	Health Clinic	Public	1999	11°8.1679'	11°01.109'
45	Zinzano HC	Pakarau	Health Clinic	Public	2000	11°8.269'	11°02.463'
46	GarinMuzam HP	Chillariye	Health Post	Public	1999	11°41.054'	11°00.057'

Primary Healthcare Center=PHCC, Primary Health care=PHC, Health post=HP, Dispensary=D, Health clinic=HC
Maternity Center=MC, Primary Healthcare=PHC, General Hospital=GH

Source: Author's field work, 2021

There are two categories of healthcare facilities in the study area i.e. primary and secondary based on the type of services they offered; table 2.

Table 2: Categories of Health Care Facilities

Category of HCF	Absolute Frequency	Percentage
Primary	45	98
Secondary	1	2
Total	**46**	**100**

Source: Author's analysis, 2021

It could be seen from Table 2 that a total of 46 physical healthcare facilities are distributed across the study area. The primary health care (PHC) facilities which are mostly provided by the state or local government constitutes the highest percentage 98% (45), while the secondary healthcare (SHC) constitutes 2% (1), this signified that primary health care facilities are predominant in the study area, and this could be attributed to being the first point of contact to obtain health care services. Thus, the available SHC facilities in the area are mostly provided by the general hospital and this constitutes 2%, this indicates that there is no adequate intervention by the private health care providers. The study area had primary and secondary health care facilities without any tertiary health care facility and also without a single private hospital or clinic across the entire 11 political zones of Nangere LGA. This is similar to the findings of Mohammed et al., (2015) which identified only primary and secondary health care facilities in Giwa LGA of Kaduna State. The tertiary healthcare facilities consist of highly specialized services, such as orthopedic, eye, psychiatric, and pediatric cases among others. These services are provided by teaching hospitals (TH), federal medical centers (FMC) and at specialist hospitals, appropriate support services are incorporated into the development of these tertiary facilities to provide effective referral services.

Table 3 show the distribution of healthcare facilities in Nangere local government area, the distribution indicates that Dazigau, Degubi, Darin, Pakarau, and Tikau have five (5) healthcare facilities, Dawasa/Garin Baba, Kukuri, Nangere and Watinani have four (4) healthcare facilities, while Dadiso has three (3) healthcare facilities and Chilariye have two (2) healthcare facilities. It's clear from the distribution that Dazigau, Degubi, Darin, Pakarau, and Tikau have the highest number of healthcare facilities while Chilariye has the least number of healthcare facilities, this shows that health care facilities are not evenly distributed in Nangere LGA. This agrees with the findings of Abbas et al., (2012) which revealed that there was inequality in the distribution of Health Care facilities in Chikun LGA of Kaduna State, the public health centers were found to be clustered along the Eastern part of Chikun LGA in Kamazou, Kujama, Kakau, Sabon Gaya districts while 6 (33.4%) of the public health centers were found at the southern part of the study area in Chikun and Gwagwada districts and none existed at the northwestern part of the study area. A similarity can be drawn with a study conducted by Mohammed et al., (2015) that revealed inconsistency in the distribution of health faculties in Giwa LGA of Kaduna state.

The table further revealed that out of the 46 healthcare facilities in the study area only 1 is general hospital (GH) which is the major healthcare facility in the local government (LG) mostly provide intensive care, critical care and long-term care, which is in line with the minimum requirement for LGA in Nigeria, to serve as a referral center for primary health facilities in the LGA, 14 were health posts (HP) which provide mostly preventive services with little or no clinical care; 10 health clinics (HC) which were to be peripheral health facility; 5 dispensaries (D) which focused on dispenses medications, 3 were maternity center (MC) mainly proved maternity services, 2 primary healthcare (PHC) which were intermediate health facility and 11 primary healthcare centre's (PHCC) serving as the referral for the health clinics and primary health centre's respectively, this indicate that majority of the healthcare facilities in the study area are health posts with only one secondary healthcare facilities.

Table 3: Distribution of Health Care Facilities

Ward	HCF	GH	PHCC	MC	HP	D	HC	PHC
Chilariye	2	0	1	0	1	0	0	0
Dadi/Chikuriwa	3	0	1	0	2	0	0	0
Dawasa/Garin Baba	4	0	1	1	0	2	0	0
Dazigau	5	0	1	0	2	1	1	0
Degubi	5	0	1	0	3	0	0	1
Kukuri/Chiromari	4	0	1	1	0	1	1	0
Darin/Langawa	5	0	1	0	4	0	0	0
Nangere	4	1	1	0	0	0	2	0
Pakarau	5	0	1	1	0	0	3	0
Tikau	5	0	1	0	2	0	1	1
Watinani	4	0	1	0	0	1	2	0
Total	**46**	**1**	**11**	**3**	**14**	**5**	**10**	**2**

HCF= Health Care Facility, GH= General Hospital, PHCC= Primary Health Clinic, MC= Maternity Center, HP= Health Post, D= Dispensary, HC= Health Clinic, PHC= Primary Health Care.

Source: Author's analysis, 2021

However, Figure 1 shows the visual distribution of HCFs in Nangere LGA. The Primary healthcare centers are evenly distributed across the study area but other healthcare facilities are unevenly distributed, this might be attributed to the denser population of those areas and other location factors. This goes in line with (Wang, 2011) that said series of location factors may be responsible for the distribution of Health Care facilities in an area, the factors may include population size, easy access to the facility from other nearby settlements, availability of approachable roads, mode of transport or impediment like water bodies, forest, and rugged terrain, etc. This agrees with the findings of Abbas et al., (2012) which revealed that there was inequality in the distribution of health care facilities in Chikun LGA of Kaduna State, the public health centers were found to be clustered along the Eastern part of Chikun LGA in Kamazou, Kujama, Kakau, Sabon Gaya districts while 6 (33.4%)of the public health

centers were found at the southern part of the study area in Chikun and Gwagwalada districts and none existed at the northwestern part of the study area. A similarity can be drawn with a study conducted by Mohammed et al., (2015) that revealed inconsistency in the distribution of health facilities in Giwa LGA of Kaduna state.

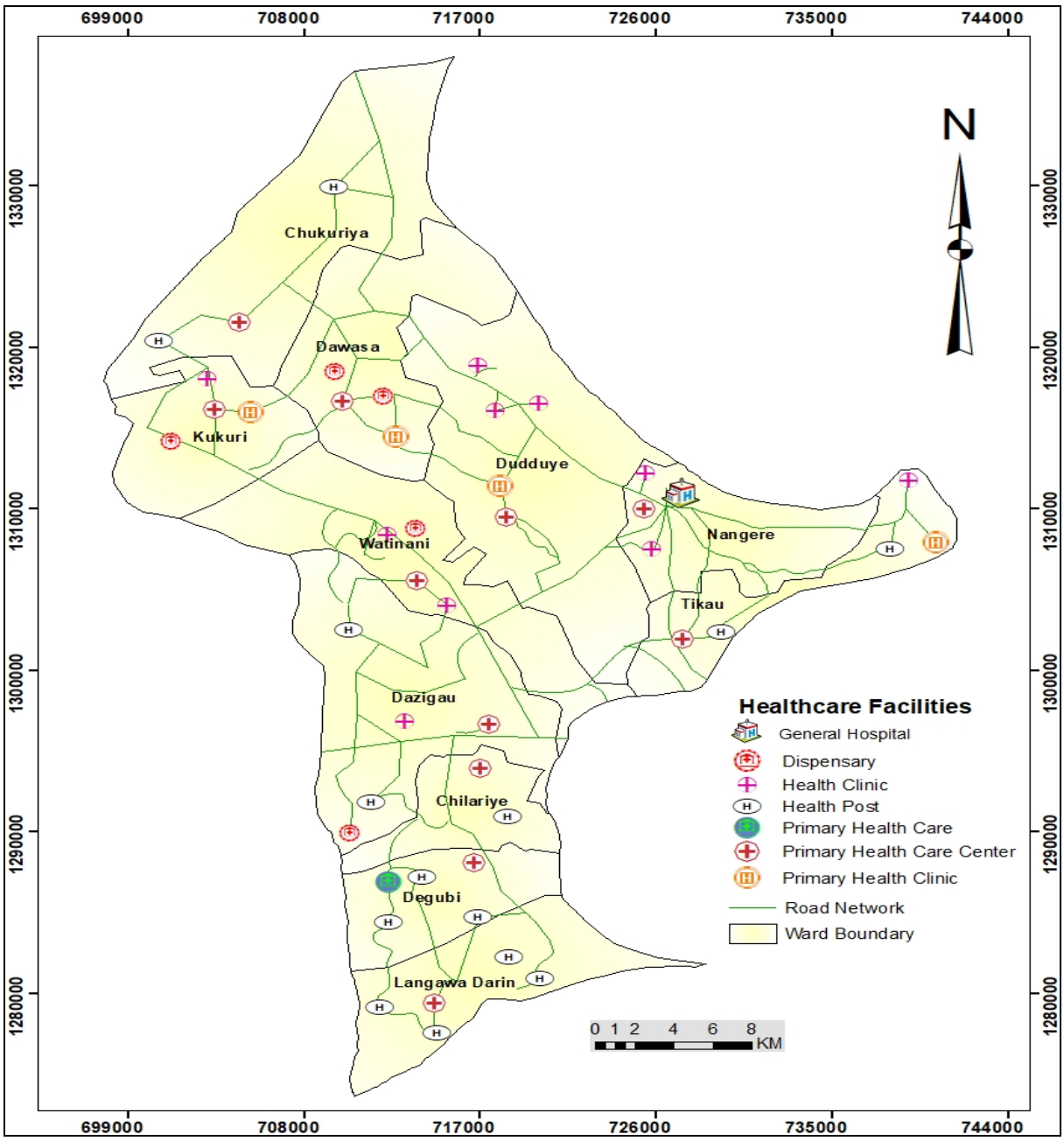

Figure 1: Spatial Distribution of Health Care Facilities
Source: Author's Analysis, 2021

The distribution pattern of health care facilities in the study area was determined by the average nearest neighbor in the ArcGIS 10.8 software interface. The average nearest neighbor analysis calculates the nearest neighbor index, which is a measure of the distance between each facility centroids and its nearest neighbor's centroid location. These parameters were used as the basis for determining whether the distribution is random, dispersed, or clustered. The spatial pattern of the health care facilities in the study area is shown in Figure 2 while the average nearest neighbor statistics is shown in Table 4.

Table 4: Summary of Average Nearest Neighbor Statistics

Average Nearest Neighbor Summary	
Observed Mean Distance:	3301.1390 Meters
Expected Mean Distance:	3032.8676 Meters
Nearest Neighbor Ratio:	1.088455
z-score:	1.135162
p-value:	0.256307

Source: Author's Analysis, 2021

The result presented in Figure 2 shows the average nearest neighbor summary for the study area; the significant level and the critical level which indicates a random distribution pattern of health care facilities in the area. Furthermore, Table 4 shows that the nearest neighbor ratio for the spatial pattern of health care facilities in the area is 1.088455 with a critical value (z-score) of 1.135162 at 0.256307 level of significance (p-value), according to Getis&Ord (1998), the z-score usually returns a range of

values between -2.58 to 2.58; therefore, a positive z-score less than 2.58 indicates a significant clustering at 0.01 probability level. A range of scores between both 2.58 to -1.96 at 0.05 significant levels and -1.96 to -1.65 at 0.10 probability level shows that there is a tendency towards a clustered pattern. A range of z-scores between -1.65 to 1.65 indicates a random distribution. Again, if the z-score lies between both 1.65 to 1.95 at 0.10 significance level and 1.96 to 2.58 at 0.05 significance level then it is obvious that there is a tendency towards a regular pattern. Therefore, since the z-score is approximately 1.14 which is less than the standard critical value of 2.58 as measured by (Getis&Ord, 1998), then the pattern is significantly even which greater than 1% (0.01 level of significance), this affirms that the location pattern of Health Care Facilities in the study area is statistically random.

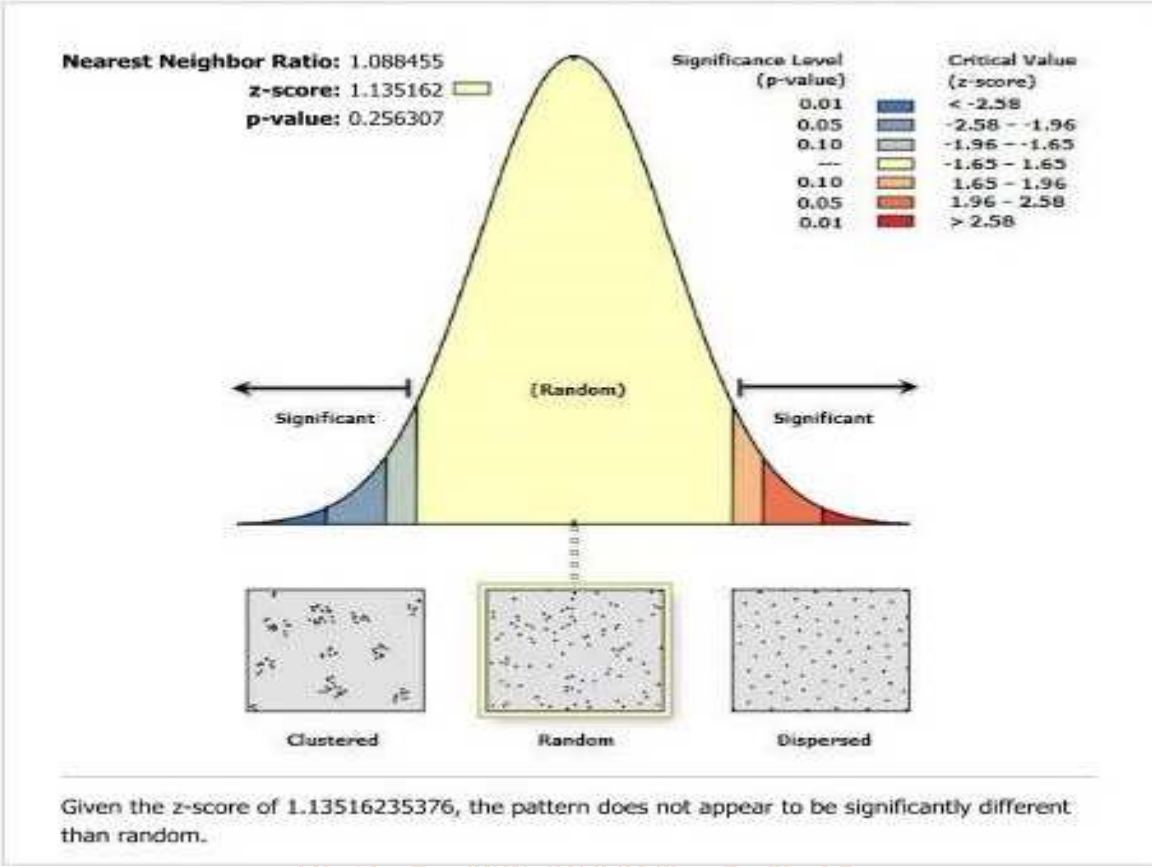

Figure 2: Pattern of Health Care Distribution
Source: Author's Analysis, 2021.

On the contrary, the result further differs with many research findings, including among the other, the work of Kibon& Ahmed (2012) who discovered that pattern of health care facilities in the Kano metropolis, Kano State of Nigeria was clustered and haphazardly distributed. Likewise, Musa &Abdulhamed (2012) findings revealed that the health care facilities in Jigawa State, Nigeria were unevenly distributed. Also, Umar (2016) in his study of the spatial distribution of health care facilities in the Kano South senatorial zone revealed that the location pattern of primary health care facilities in the area was dispersed as shown by the Average Nearest Neighbor analysis.

CONCLUSIONS

In conclusion, this study was able to identify and mapped the health care facilities across the entire 11 geo-political wards of Nangere Local Government area of Yobe state; the findings revealed the total number of health care facilities across the 11 geo-political wards of NangereLocal Government area and the distribution suggests that health care facilities are not evenly distributed in the area. The study identified 46 physical healthcare facilities distributed across space, categories into two, namely, primary health care (PHC) facilities which are mostly provided by the state or local government constitutes the highest percentage 98% (45) while the secondary healthcare (SHC) constitutes 2% (1), this signified that primary health care facilities are predominant in the study area. Further, disaggregating the PHC, 14 were health posts; 9 health clinics; 5 dispensaries, 6 primary health care and 11 primary healthcare centers (PHCC).

Health Care Facilities in the study area are statistically random, the study area is fairly provided with primary health care facilities. However, it was unevenly distributed given the concentration of health care facilities in Dazigau, Degubi, Darin, Pakarau, and Tikau while other wards were inadequately served. Thus, this disparity in the distribution of health facilities has generated different accessibility levels to health care facilities in the LGA. The study concluded that there were inequalities in the spatial distribution of healthcare facilities in the Nangere Local Government Area of Yobe state, thus this disparity in the distribution of health facilities has generated different accessibility levels to health care facilities in the LGA. In light of the problems associated with inequalities in the spatial distribution revealed in this study; it, therefore, recommends that; Government and Non-governmental organizations should provide health care facilities in the wards that do not have enough health care facilities. This will further improve access to Health Care facilities in the study area.

REFERENCES

[1] Abbas, I. I., Auta, S. Z., & Muhammad, R. (2012). Health Care Facilities Mapping and Database Creation Using GIS in Chikun Local Government, Kaduna State, Nigeria. Global Journal of Human, Social Science. *Geography & Environmental GeoSciences*, *12*(10).

[2] Burrough, P. (2001). *Principles of Geographic Information Systems Spatial Information Systems and Geo-informatics*. Oxford University Press.

[3] Cromley, E. K., & McLafferty, S. (2002). *GIS and public health*. Guilford Press.

[4] Getis, A., & Ord, J. K. (1998). *Spatial analysis: Modeling in a GIS environment. In P. Longley, & M . Batty (Eds.), Local spatial statistics*. John Wiley & Sons.

[5] Ghosh, D. (2001). Participatory Mapping as a Component of Operational Malaria Vector Control in Tanzania.In Geospatial Analysis of Environmental Health. *Geotechnologies and the Environment*, *4*(1). https://doi.org/DOI 10.1007/978-94-007-0329-2_7

[6] Glass, G., Schwartz, B., Morgan, J., Johnson, D., Noy, P., & Israel, E. (1995). Environmental risk factors for Lyme disease identified with GIS. *American J Ournal of Public Health*, *85*(7), 944–948.

[7] INEC. (2019). *Polling unit locator tool*. Independent National Electoral Commission.

[8] Kibon, U. A., & Ahmed, M. (2012). Distribution of primary health care facilities in Kano metropolis using GIS (Geographic Information System). *Research Journal of Environmental and Earth Science*, *5*(4). https://doi.org/https://doi.org./10.19026/rjees.5.5710

[9] Lovett, A., Parfitt, J., & Brainard, J. (2006). Using GIS in risk analysis: a case study of hazardous waste transport. *Risk Anal*, *17*(5), 625–633.

[10] McMaster, R. (1988). Modeling community vulnerability to hazardous materials using geographic information systems. *Proceedings, Third International Symposium on Spatial Data Handling*, 143–156.

[11] Mohammed, I., Musa, I. J., Salisu, A., Kim, I., Oyalem, A. M., & Maiwada, A. (2015). Analysis of accessibility to health care facilities in Giwa and Tofa Local Government areas of Nigeria: GIS approach. *Journal of Scientific Research and Reports*, *3*(22), 2900–2915.

[12] Musa, I. J., & Abdulhamed, I. (2012). The Accessibility problems of primary Health Care to rural people in Jigawa state, Nigeria. *Global Advance Research Journal of Social Science*, *1*(4), 72-76. https://doi.org/http://garj.org/garjss/index.htm

[13] Natinal Population Commission. (2021). National housing Demarcation Survey. *NPC*.

[14] Openshaw, S., Charlton, M., & Craft, A. (1988). Searching for leukemia clusters using a geographical analysis machine. *A Paper Presented at the 11th World Conference of the Society for International Development*, 64:95–106.

[15] Wang, L. (2011). Analyzing spatial accessibility to health care: a case study of access by different immigrant groups to primary care physicians in Toronto. *Annals of GIS*, *17*(4), 237–251. https://doi.org/https://doi.org/10.1080/19475683.2011.625975

[16] Wartenberg, D. (1992). Screening for lead exposure using geographic informaiton system. *Environ Mental Resources*, *59*(1), 310–317.

[17] Wartenberg, D., Greenberg, M., & Lathrop, R. (1993). Identification and characterization of populations living near high-voltage transmission lines. *Environmental Health Perspect*, *101*(7), 626–631.

[18] WHO. (1997). *Geographic Information Systems and Public Health Mapping*. World Health Organization.

[1]