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Spatial Analysis of Distribution Patterns of Healthcare Facilities in Nangere Local Government Area of Yobe State, Nigeria

Usman Adamu
Lecturer, Department of Geography,
Yobe State University Damaturu, Yobe State, Nigeria
Ibrahim Abubakar Audu
Graduate Assistant, Department of Environmental and Resource Management,
Usmanu Danfodiyo University Sokoto, Sokoto State, Nigeria

Abstract:
The paper examined the spatial analysis of distribution patterns of healthcare facilities in Nangere Local Government Area of Yobe State. These were with a view to improve the spatial distribution and equitable access to healthcare facilities in the State. Primary and secondary data were used in the study. The primary data comprised the geographic coordinates of all the healthcare facilities in the local government using the Global Positioning System (GPS) Garmin GPS map 76CS receiver, while the secondary data included the list of all the healthcare facilities in the local government and the documented materials from unpublished and published dissertations and thesis, journals, textbooks, internet materials and conference papers. The data were analyzed using percentage and Geographical Information System (GIS) analysis tools such as nearest neighbor ratio (NNR). The study identified 46 physical healthcare facilities distributed across the space, categories in to 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 centres' (PHCC). The average nearest neighbor summary for the study area shows the significant level and the critical level which indicates a random distribution pattern of health care facilities in the area. Furthermore, the nearest neighbor ratio for the spatial pattern of health care facilities in the area is 1.088455 with critical value (z-score) of 1.135162 at 0.256307 level of significance (p-value), therefore, since the z-score is approximately 1.14 which is less than the standard critical value of 2.58, then the pattern is significantly even which greater than 1% (0.01 level of significance), this affirms that the locational pattern of health care facilities in Nangere local government area is statistically random. The study concluded that there were inequalities in the spatial distribution of healthcare facilities in Nangere local government area of Yobe state.

Keywords: Healthcare facilities, distribution, patterns, geographic, information, system

1. Introduction

In Nigeria, much concern has been focused on providing the basic needs of the people as a strategy to reduce the level of poverty in the society, hence the concern for the spatial patterns of distribution of the basic development needs that affect the wellbeing of the people. This concern derived greater inspiration from the level of the United Nations (UN) through the setting of 2015 as target period for achieving the Millennium Development Goals (MDGs) (UN 2000). The MDGs were developed in the year 2000 during a global convention with 187 countries including Nigeria in attendance to fashion out ways of achieving realistic development by providing those basic needs that would reduce poverty in society (UN 2000, World Bank 2002). In Nigeria, the health sector is one area where much concern is directed. This is because a healthy population is a prosperous one as it influences the level of productivity in all ramifications.

According to welfare economic theory, equity in the distribution of basic development needs is indicative of the degree of accessibility of population to such services and facilities. Thus, knowledge on the nature of distribution of health care facilities is expedient in understanding the level of success or otherwise of health care delivery system in any society. Access to healthcare services is essential for the well-being of humans. Studies have shown that the location of healthcare facilities do not always correspond to the needs of the population in most local government areas in Yobe state. This has resulted in poor healthcare delivery. Overt attention has also not been given to the need for equitable distribution of these facilities which are germane to good healthcare delivery Njoku and Akpan (2011); Ahmed and Mohamad (2013); Ayoade (2014); Fadahunsi (2016).

In Yobe State as it is in most parts of the country, there is the dual problem of inadequate facilities and high level of poverty which with resultant low personal mobility, constrained access to health care facilities. It is therefore

imperative to examine the spatial distribution of health care facilities in Nangere local government area. In Yobe state of Nigeria, explicit consideration has not been given to the need for equity in the distribution of the healthcare facilities. This has led to the emergence of many settlements within the State where healthcare facilities are sparsely provided Ogunjumo (2005). Attempt to address such inequity in the distribution of these healthcare facilities may require the use of information management tool such as the Geographic Information System (GIS). As a result, this study examined distribution patterns of healthcare facilities in Nangere local government area of Yobe state using GIS technique, with a view to improving the spatial distribution of and equitable access to healthcare facilities in the State. This is important because the health status of residents has implications on their productivity and the development of the State.

1.1. The Study Area

Nangere local government area is domiciled in Yobe state, North-east geopolitical zone of Nigeria and has its headquarters in the town of Sabon Gari Nangere located between 11°51'50''N 11°04'11''E/ 11.86389°N 11.06972°E as can be seen in figure 3.1 bellow. 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. It has an area of 980 km². The study area has a total of 11 electoral wards namely: Chilariye, Dadiso/Chukuriwa, Dawasa/Garinbaba, Dazigau, Degubi, Kukuri/Chiromari, Langawa/Darin, Nangere, Pakarau Kare Kare/Pakarau Fulani, Tikau, and Watinani wards ([INEC], 2019).
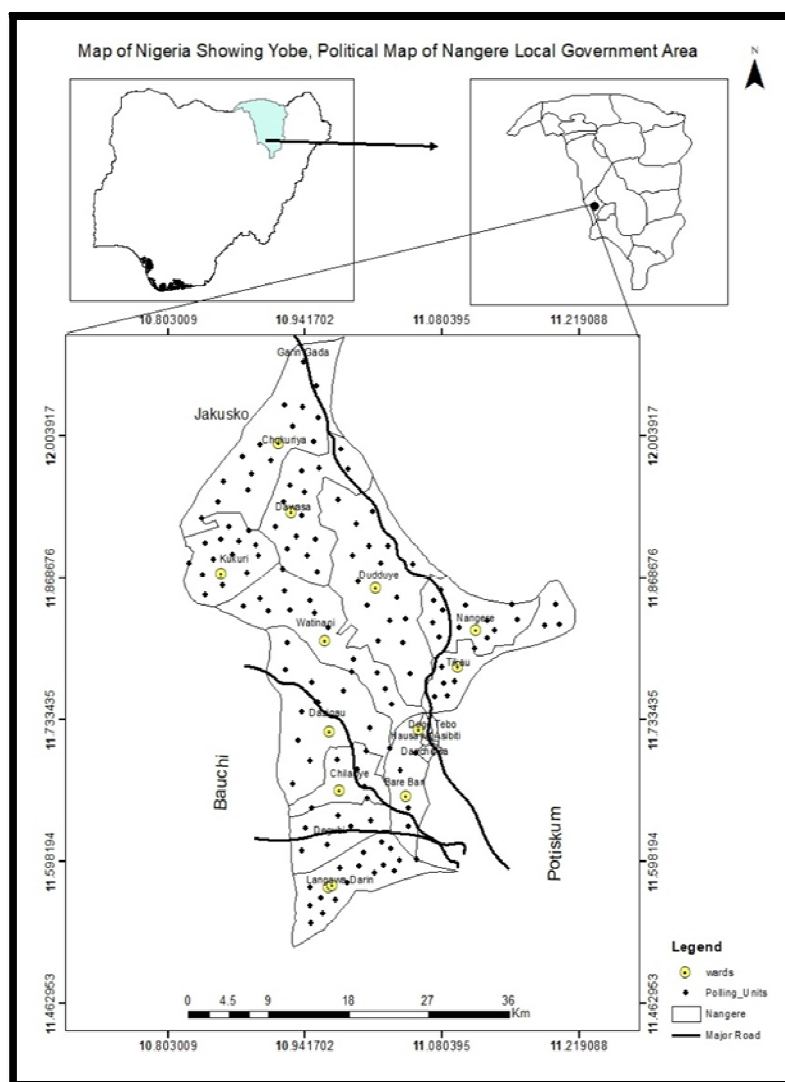

Figure 1: The Study Area
Source: Adapted from Administrative Map of Yobe State (2020)

2. Methodology

2.1. Types and Sources of Data

The list of existing healthcare facilities in Nangere local government was obtained from Yobe state ministry of health Damaturu as at 2020. The geographic coordinates of the health care facilities were also obtained from the field survey using the Global Positioning System (GPS) Garmin GPS map 76CS receiver. The documented materials from

unpublished and published dissertations and thesis, journals, textbooks, internet materials, seminar, conference papers and encyclopedia are used for literature review.

2.2. Techniques of Data Processing

The administrative map of the study area is scanned and imported into ArcGIS 10.5 software for geo-referencing. Geo-referencing relates space object or raster object that has not been tied to any geographic reference to a coordinate reference system. There by allowing various independent GIS datasets to be brought together as overlay of geographic information.

2.3. Method of Data Analysis

An inventory of all the healthcare facilities is taken, this includes names of facility and geographic coordinates of the healthcare facilities is structured into Microsoft Excel. The required number of fields (columns) was added to the table and the data for all the healthcare facilities were entered into their corresponding records (rows). The GPS coordinates were also imported into ArcGIS 10.5 interface. Consequently, the x and y spontaneously displayed the geo-referenced location of each health care facility in space; this aided the visualization of the distribution of all the types of health care facilities in the study area. The study further built on the output map of the health care facilities distribution to determine the spatial pattern.

Hence, the Nearest Neighbor Analysis (NNA) inferential statistical tool in ArcGIS10.5 was used to investigate the spatial pattern in the data. This tool automatically calculated the local government area and the average nearest neighbor ratio by dividing the observed average distance by the expected average distance. NNA is the method of exploring pattern in the location data by comparing mean distance (Do) of a phenomenon to the same expected mean distance (De) usually under random distribution. A negative z-score indicates clustering, while a positive z-score means disperse or evenness. Moreover, the z-score usually returns a range of values between -2.58 to 2.58. Therefore, a negative z-score less than -2.58 indicates a significant clustering at 0.01 probability level. On the other hand, a positive z-score greater than 2.58 indicates a significant regularity or dispersal at 0.01 probability level (Getis & Ord, 1998).

3. Results and Discussion

The distribution pattern of health care facilities in the study area was determined by average nearest neighbor in ArcGIS 10.5 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 the 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 3. The distribution patterns of existing healthcare facilities in Nangere local government were examined using percentage and nearest neighbor ratio (NNR) analysis tool of ArcGIS. A summary of the categories of healthcare facilities in Nangere local government is provided in Table1 and figure 1. The table and the figure show that at the time of this study, there were 46 healthcare facilities in the local government; these include three 1 (2%) secondary healthcare facilities, 45 (98%) primary healthcare facilities.

Category of HCF	Absolute Frequency
Primary	45
Secondary	**1**
Total	**46**

Table 1: Categories of Health Care
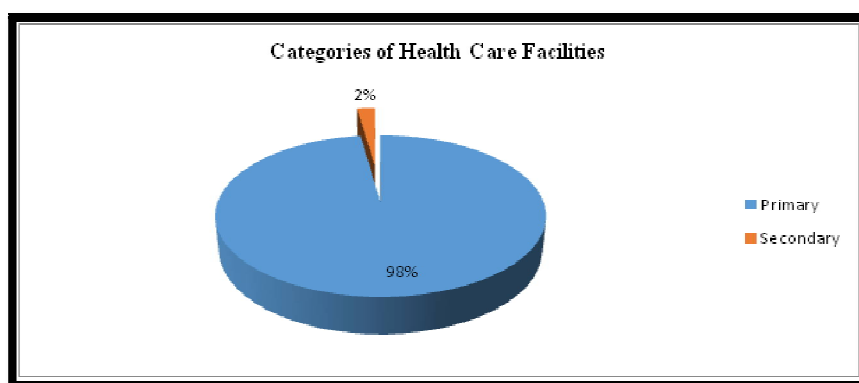*Facilities in Nangere LGA*
Source: Author's analysis, 2020

Figure 2: Pie Chart of Categories of Healthcare Facilities in Nangere LGA

It could be seen from Table 1, that a total of 46 physical healthcare facilities are distributed across the study area. From Figure 2 above shows that 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. Further, disaggregating the PHC, 14 were health posts which provide mostly preventive services with little or no clinical care; 9 health clinics which were to be peripheral health facility; 5 dispensaries which focused on dispenses medications, 6 primary healthcare which were intermediate health facility and 11 primary healthcare centre's serving as the referral for the health clinics and primary health centre's respectively.

According to Abdurrahman and Nurunnisa (2013), Secondary health care (SHC) level provides specialized services to patients who are referred from the primary health care level. These services are provided through out-patient and in-patient hospital services, which include general medical, surgical, and pediatric cases and community health services. Adequate supportive services, such as laboratory, diagnostics, blood bank, rehabilitation and physiotherapy are also provided. 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. 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.

Ward	Number of 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**

Table 2: Distribution of Health Care Facilities in Nangere LGA
HCF= Health Care Facility, GH= General Hospital, PHCC= Primary Health Care Center,
MC= Maternity Center, HP= Health Post, D= Dispensary, HC= Health Clinic, PHC= Primary Health Care
Source: Author's analysis, 2020

Table 2 show the distribution of healthcare facilities in Nangere local government area, the distribution suggests that health care facilities are not evenly distributed in Nangere LGA. This agrees with the findings of Abbas, (2012) which revealed that there was inequality in the distribution of Health Care facilities in Chikun LGA of Kaduna State, the public health centres 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 centres 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 Muhammed *et al.,* (2014) that revealed inconsistency in the distribution of health faculties in Giwa LGA of Kaduna state. An inventory of all the healthcare facilities in Nangere local government area is shown in table 3 below. The inventory displays the name of facility, geo-political ward, types of facility, latitude and longitude of each health care facility in the study area.

S/No	Name of Facility	Ward	Types of Facility	Latitude	Longitude
1	Garin Muzam HP	Chillariye	Health Post	11°41.054'	11°00.057'
2	Chillariye PHCC	Chillariye	Primary Health Care Center	11°41.957'	10°59.436'
3	Dagare PHCC	Darin/L	Primary Health Care Center	11°36.023'	11°01.099'
4	Darin HP	Darin/L	Health Post	11°34.617'	10°56.555'
5	Dorawa Dadi HP	Darin/L	Health Post	11°33.062'	10°59.324'
6	Fadawa HP	Darin/L	Health Post	11°34.497'	11°00.397'
7	Katariya HP	Darin/L	Health Post	11°6.0213'	11°06.571'
8	Challino PHC	Degubi	Primary Health Care	11°38.538'	10°56.905'
9	Gabur HP	Degubi	Health Post	11°36.809'	10°56.800'
10	Gwasko HP	Degubi	Health Post	11°38.315'	10°57.756'
11	Mbela HP	Degubi	Health Post	11°36.952'	10°59.323'
12	Degubi PHCC	Degubi	Primary Health Care Center	11°38.794'	10°59.246'
13	Dazigau PHCC	Dazigau	Primary Health Care Center	11°43.438'	10°59.671'
14	Gudi PHC	Dazigau	Primary Health Clinic	11°45.353'	10°57.936'

S/No	Name of Facility	Ward	Types of Facility	Latitude	Longitude
15	Gabarun HP	Dazigau	Health Post	11°46.622'	10°55.751'
16	Garin Shera D	Dazigau	Dispensary	11°39.792'	10°55.750'
17	Yaru HP	Dazigau	Health Post	11°40.842'	10°56.352'
18	Tudun Wada HC	Tikau	Health Clinic	11°51.540'	11°11.555'
19	Dagazurwa PHC	Tikau	Primary Health Clinic	11°49.431'	11°12.305'
20	Dagaretikau HP	Tikau	Health Post	11°49.231'	11°11.032
21	Tikau PHCC	Tikau	Primary Health Care Center	11°46.249'	11°05.160'
23	Kael HP	Tikau	Health Post	11°47.679'	11°07.560'
24	Old Nangere HC	Nangere	Health Clinic	11°51.840'	11°04.167'
25	Sabon Gari PHCC	Nangere	Primary Health Care Center	11°50.921	11°04.492'
26	Nangere GH	Nangere	General Hospital	11°51.402'	11°04.457'
27	Garin Jata HC	Nangere	Health Clinic	11°8.3665'	11°13.286'
27	Baran Iya HC	Watinani	Health Clinic	11°8.7927'	10°9.6776'
28	Dugum HC	Watinani	Health Clinic	11°8.3948'	10°9.5593'
29	Garin Gambo DP	Watinani	Dispensary	11°8.5249'	10°9.0211'
30	Watinani PHCC	Watinani	Primary Health Care Center	11°7.5891'	11°01.042'
31	Garin Kadai HC	Kukuri/C	Health Clinic	11°55.463'	10°51.846'
32	Kukuri PHCC	Kukuri/C	Primary Health Care Center	11°8.8711'	10°8.5293'
33	Kukuri PHC	Kukuri/C	Primary Health Clinic	11°8.8778'	10°8.5606'
34	Haram DP	Kukuri/C	Dispensary	11°54.351'	10°55.647'
35	Chukuriwa PHCC	Chukuriwa/D	Primary Health Care Center	11°56.989'	10°52.763'
36	Dadiso HP	Chukuriwa/D	Health Post	11°56.376'	10°50.490'
37	Gada HP	Chukuriwa/D	Health Post	12°08.693'	10°9.3291'
38	Bagaldi DP	Dawasa/GB	Dispensary	11°8.8395'	10°9.45261'
39	Dawasa PHCC	Dawasa/GB	Primary Health Care Center	11°7.084'	11°04.748'
40	Dawasa PHC	Dawasa/GB	Primary Health Clinic	11°7.0172'	11°04.751'
41	Garin Baba DP	Dawasa/GB	Dispensary	11°69.247'	11°03.337'
42	Biriri HC	Pakarau	Health Clinic	11°9.4627'	11°01.665'
43	Duddaye PHCC	Pakarau	Primary Health Care Center	11°8.0367'	10°9.9579'
44	Garin Keri PHC	Pakarau	Primary Health Clinic	11°8.7049'	10°9.8586'
45	Katsira HC	Pakarau	Health Clinic	11°8.1679'	11°01.109'
46	Zinzano HC	Pakarau	Health Clinic	11°8.269'	11°02.463'

Table 3: Inventory of Health Care Facilities in Nangere Local Government Area
Source: Author's field work, 2020

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 3 shows that the nearest neighbor ratio for the spatial pattern of health care facilities in the area is 1.088455 with critical value (z-score) of 1.135162 at 0.256307 level of significance (p-value), according to Getis and 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 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 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 and Ord (1998), then the pattern is significantly even which greater than 1% (0.01 level of significance), this affirms that the locational pattern of Health Care facilities in the study area is statistically random.

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

Table 4: Summary of Average Nearest Neighbor Statistics
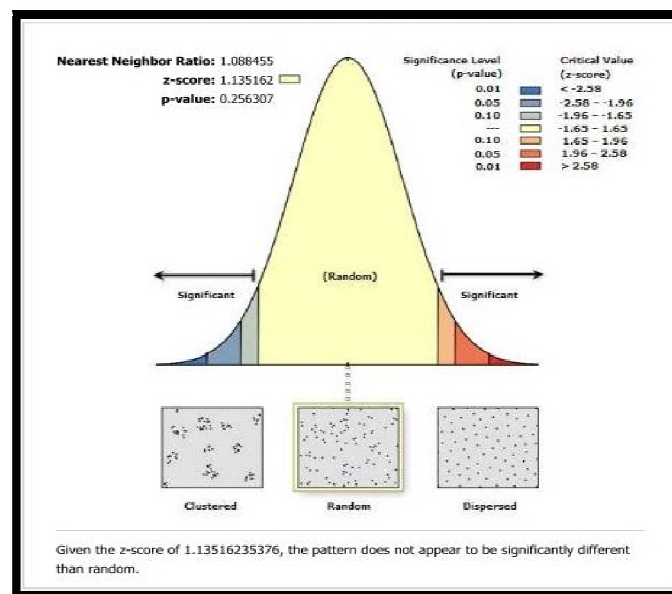*Source: Author's Analysis, 2020*

Figure 3: Pattern of Health Care Distribution in Nangere LGA
Source: Author's Analysis, 2020

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

4. Conclusions

The study reveals that there were 46 healthcare facilities in the local government; these include 1 (2%) secondary healthcare facilities and 45 (98%) primary healthcare facilities. Primary healthcare facilities depicted is statistically random distributional patterns. The findings revealed that the distribution of healthcare facilities in Nangere local government area suggests that health care facilities are not evenly distributed in the area. This study has also effectively showcased the capability of GIS as a veritable tool for decision support system for examining the spatial distribution and site selection of new healthcare facilities

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