



Analysis of Accessibility to Healthcare Facilities in Giwa and Tofa Local Government Areas of Nigeria: GIS Approach

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Authors' contributions

This work was carried out in collaboration between all authors. Author MI designed the study, wrote the protocol, performed the GIS analysis, wrote the first draft of the manuscript, and reviewed the final draft of the manuscript. Authors AM and IK managed the literature searches. Authors AS, AMO and AMY carried out the field survey. Author IJM supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The objective of the National Health Policy (1988) in Nigeria is to provide the population with access to primary, secondary and tertiary healthcare as needed through a functional referral system. In this paper, Geographic Information System (GIS) is employed to examine a very important aspect of the policy, that is, accessibility to healthcare facilities in the rural areas which constitute a very large population of the country.

Study Design: The situation in Giwa and Tofa Local Government Areas respectively in Kaduna and Kano States of North western Nigeria is examined, with a view to identify the patronage pattern and the level of accessibility to the healthcare facilities in the rural areas in order to guide healthcare policy formulation and implementation in Nigeria.

Methodology: Locational access to healthcare facilities was established for all the 26 electoral wards across Giwa and Tofa LGAs. Using network analyst tool in ArcGIS, cost OD (Origin Destination) matrix was created using the population weighted centroid of each electoral ward as origins and the healthcare facilities as destinations. The average nearest neighbourhood analysis was done to determine the spatial randomness of the healthcare facilities. From these data, indices of community healthcare accessibility for the LGAs neighbourhoods were constructed. In addition, structured questionnaires were administered through a systematic random sampling to patients at the General hospitals in the LGAs and oral interviews conducted with those who do not patronise the hospitals. The data from the questionnaire survey was analysed using both the descriptive and inferential statistics.

Results: Findings showed that healthcare facilities in some of the wards are grossly inadequate, their distribution is random hence many of the electoral wards are poorly served or underserved. Findings revealed that some people travel a distance of up to 30km to access the nearest healthcare facility.

Conclusion: There is the need for provision of more healthcare centres in the areas which should be distributed fairly and logically.

Keywords: Accessibility; network analysis; neighbourhoods; healthcare facilities; geographic information system (GIS) analysis.

1. INTRODUCTION

In Nigeria, the First Development Plan (1962-1968) [1] and [2] recognised that a healthy population is an economic asset and acknowledged the need to make health services and facilities available and accessible to the general population. However, [3] observed that “poor management continues to be a serious handicap in the effective delivery of health services in the country, health facilities are in short supply and the available one are inefficiently utilised”. But, effective delivery and management of healthcare services is achieved if there are effective legislations that are fully implemented, timely evaluated and properly reviewed.

All countries have legislations that established healthcare services for its citizens. The Federal Government of Nigeria adopted a National Health Policy in 1998. The objective of the policy is to provide the population with access to primary, secondary and tertiary healthcare as needed through a functional referral system. It recognises that the provision of health services is a responsibility of the federal, state and local governments; as well as civil

societies and Non-governmental organisations. But [4] reported that over seventy percent of the population living in rural areas and a good number in semi-urban towns in Nigeria have a serious problem of access to quality healthcare. This cannot be unconnected with partial implementation, untimely evaluation and review of the health policies in the country. An important aspect of the health policy that requires timely evaluation and proper review is accessibility to healthcare facilities especially in the rural areas. This is because the location of and accessibility to healthcare facilities in a given geographical area influence their utilisation. Also, the nature and extent of health problems as well as the threshold population demanding healthcare services in a given location influence the decision of the government on the type of healthcare services to be provided in the area. In Nigeria, primary healthcare is largely the responsibility of the local governments with the support of the state, while secondary healthcare is the responsibility of the state government, whereas tertiary healthcare is the responsibility of the federal and state governments.

Previous works have focused on location and distribution of healthcare facilities in Nigeria. For instance, [5] used field survey, cartographic and geographic information techniques to examine the spatial pattern of health care delivery facilities in part of the Niger Delta region of Nigeria. He discovered that a vast proportion of the people in the state do not have access to the available health care delivery facilities in the area but still depend on traditional medical care and self medication. Likewise, [6] utilised questionnaire survey, interview schedule and personal observation to examine the primary healthcare delivery in Owan East and Owan West local government areas of Edo State in Nigeria. He reported that insufficient medical staff and facilities in primary healthcare centres have adversely affected the health of the people in the local government areas. Moreover, findings of a study by [7] revealed that the available healthcare facilities in Osun State are grossly inadequate and they are unfairly distributed. Similarly, in a review of the distribution of healthcare facilities in Nigeria, [8] observed that from the colonial period, the distribution of medical care delivery in Nigeria has favoured the urban population at the expense of the rural settlers. In addition, [9] utilised locational quotient to examine the distribution pattern of healthcare facilities in the local government areas in Osun State of south western Nigeria. Their findings discovered the existence of gaps in access to healthcare facilities between local government areas in the state. Moreover, [10] used simple statistics to analyse the spatial patterns of health care facilities among the three senatorial districts (which corresponds to the division along major ethnic lines) in Kogi State of northcentral Nigeria. Their study revealed inequalities in the distribution of healthcare facilities among the various senatorial districts in the state. It is observed from the literature that very few studies have employed GIS to examine healthcare delivery and accessibility in Nigeria; and the few studies have only used single GIS technique to achieve their objectives. This study used multiple GIS techniques (network and neighbourhood) to analyse accessibility to healthcare facilities in Giwa and Tofa local government areas respectively in Kaduna and Kano States of North western Nigeria.

1.1 Literature Review on Network and Neighbourhood Analyses

Network and Neighbourhood Analyses have been used by scholars and researchers to analyse pattern and accessibility in various parts of the world. For example, [11] used cost path analysis 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. In addition, [12] utilised Nearest Neighbour Analysis to assess the spatial distribution of health centres in Lokoja City of Northcentral Nigeria. His findings revealed an indication of weak randomness, because p – value (0.99228) exceeds the Z-score table value of -0.723417 which is indicative of insignificant accessibility. He concluded that this

scenario is a picture of state of health facility distribution in typical Nigerian cities where health facility distributions do not adhere to any particular criteria. Also, [13] utilised Geographical information systems (GIS) and network analysis to generate different estimations of accessibility based on the existing road network and transport barriers. Moreover, [14] employed network analysis to determine the closeness of a facility and shortest route to the healthcare facilities in Enugu Urban Area of south eastern Nigeria. They also identified areas deprived of healthcare facility. Furthermore, [15] used buffer operations and Kernel Density Estimation to analyse the spatial distribution and accessibility of the healthcare delivery system in Yola. They concluded that health care facilities and physicians in Yola are grossly inadequate. This study employed both network and neighbourhood analyses to determine accessibility to healthcare facilities in Giwa and Tofa LGAs of Nigeria.

1.2 The Study Areas

1.2.1 Giwa local government area

Giwa Local Government Area is located between Latitude $10^{\circ}49' 44.43''N$ to Latitude $11^{\circ}24' 30.40''N$ and between Longitude $7^{\circ}05' 56.77''E$ to Longitude $7^{\circ}37' 51$ as shown in Fig 1. Based on the 2006 National Population Commission census in Nigeria, the area had population of 204,532. It is bordered by Sabon-Gari, Zaria, Igabi and Birnin Gwari local government areas in Kaduna State. The study area lies on the Galma plain, of 712m above sea level. Giwa represents multicultural city on the Savanna of northwestern Nigeria where several ethnic groups such as Hausa, Fulani, Yoruba, Igbo, Bajju, Jaba, Tiv, Idoma and many others live.

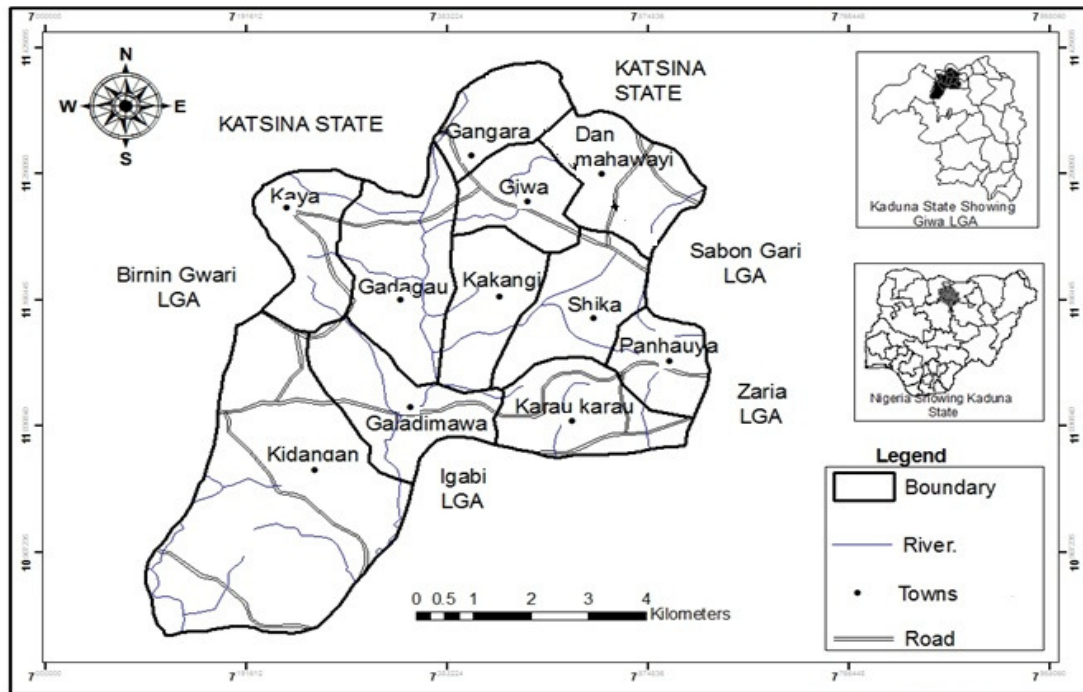


Fig. 1. Map of Giwa local government area of Kaduna state, Nigeria

1.2.2 Tofa local government area

Tofa local government is located between Latitude $12^{\circ}03^1$ North to $12^{\circ}05^1$ North and Longitude $8^{\circ}16^1$ E to $8^{\circ}26^1$ E with an area of 202km^2 as shown in Fig. 2. The population of Tofa was 98,683 as at the 2006, 49,870 Males and 48,733 Females (Census, 2006) with a population growth rate of 3.2% per annum the projected population as at 2011 is 115, 542. Tofa was created on the 23rd of September, 1991 from Dawakin Tofa local Government with its headquarters in Tofa Town of Kano State in Nigeria as shown in Fig. 2. Kano is an ancient traditional city on the Savanna of northwestern Nigeria, inhabited by the dominant indigenous Hausa community and is the most populous state in the country according to 2006 census. Therefore Tofa was chosen as a representative of Kano and compared with Giwa in Kaduna State which also falls within northwestern Nigeria but is multicultural and less populated than Kano State.

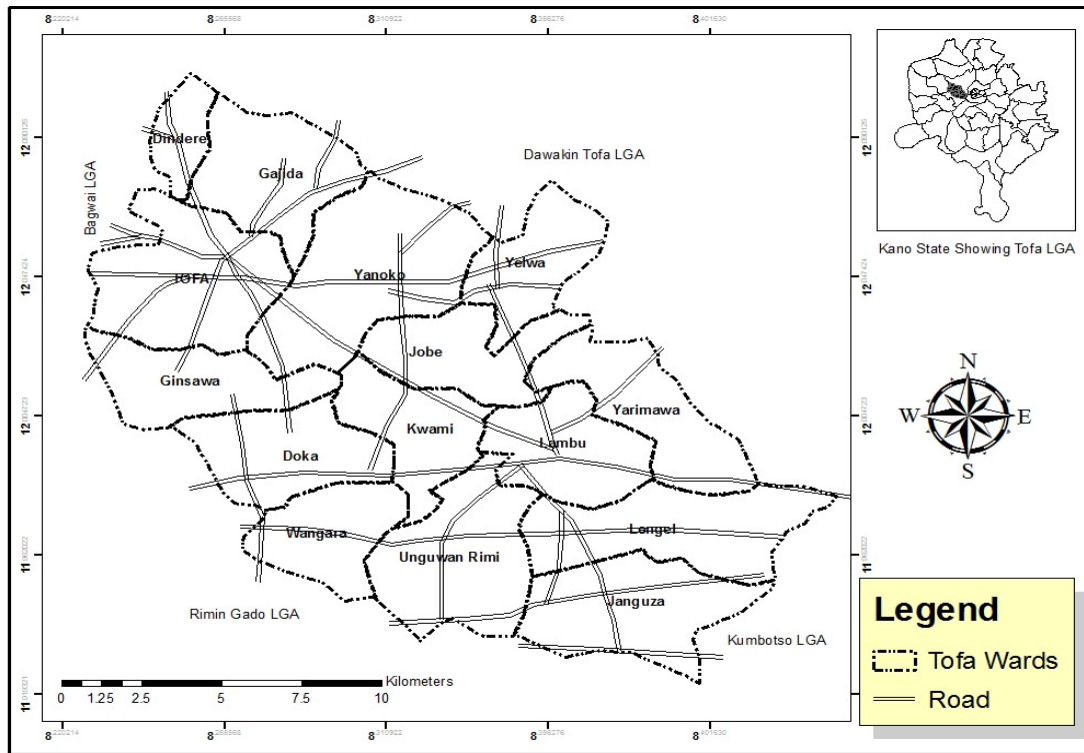


Fig. 2. Map of Tofa local government area of Kano state, Nigeria

2. METHODOLOGY

2.1 Types of Data

This study used the following types of data:

- Topographic map (2006) of the area showing the wards
- Road data for network analysis
- Population census data at ward level

- Census attribute data
- Map showing the distribution of the Health Centres

2.2 Sources of Data

Population data was obtained from National Population Commission (NPC). The population data of 1991 census was used because it is more comprehensive and provided population at ward level but was projected using linear projection method. This was combined with current 2006 population data which does not provide data at some of the wards. Road data was obtained from and Kaduna States Ministry of Transport maps.

List of healthcare facilities: these were obtained from the Ministry of Health in Kaduna and Kano states as well health departments of the LGAs on the ground that the data will be used for research purposes.

2.2.1 Field survey

For each Local Government Area, the exact location of all healthcare facilities in the electoral wards was obtained. Global Positioning System (GPS, Garmin 76 map model) was used to collect individual coordinates (latitude and longitude) of all the healthcare facilities which are converted into four decimal places in Microsoft office excel and imported into ArcGIS.

2.3 GIS Methods

The locational data (healthcare facilities) was imported from excel as point data into the ArcGIS environment and integrated with other datasets (road data, population and boundary data) which were prepared in a GIS format and integrated into the analysis. The population data was transformed into points for the analysis.

Maps of Giwa and Tofa Local Government Areas were sourced from the local government headquarters, scanned georeferenced and digitised to create shapefiles of the areas.

Healthcare facility accessibility was calculated for each of the electoral wards across the Local Government Areas. Electoral wards are units of reporting of census data in Nigeria, with each area representing variable population density. In this analysis, each electoral ward was represented by its population weighted centroid (the centre of population in the area rather than the geometric centroid) and the average distance (travel time) taken to each healthcare facility (for example, PHC or a health centre) along the road network was calculated using the network analyst functionality in ArcGIS. Population weighted centroids were used because in large rural electoral wards the geometric centroid is often positioned at a significant distance from the centre of population and hence from the road network [16]. Therefore, geometric centroid may not give the actual distance to each healthcare facility. As established by [16] to represent accessibility more accurately, it is important to use the distance between each electoral ward and the location of each facility through the road network to calculate total travel time rather than the straight line distance. Network analyst tool was used to create OD matrix and service areas.

The vector layer of the Road network was converted into network dataset for this operation. Depending upon the road hierarchy and characteristic, roads were allotted an average

vehicular speed. On the basis of the speed, travelling time and travelling distance required to be covered to approach the nearest facility service area were calculated, which were used as impedance in the analysis. Thus, the respective service area was obtained on the basis of travelling distance through the road network. This signifies the physical accessibility towards the nearest facility with time and distance band towards the facility.

Also, Neighbourhood analysis was done to determine the pattern of distribution of the healthcare facilities in the area. Population points were used as origins while the healthcare facilities were used as destinations.

2.4 Criteria for the Analysis

The provision of the 3rd National Development Plan for health in Nigeria was adopted in the analysis.

The 3rd National Development Plan for health in Nigeria (1975-1980) [17] introduced Basic Health Services Scheme (BHSC). Under the scheme:

- Health Clinics (HC) were to be peripheral health facility serving population of 2000.
- Primary Healthcare (PHC) were intermediate serving population of 20,000.
- Comprehensive Health Centres (CHC) served as the referral for the HC and PHC serving a population of 40-50000.
- Mobile Clinics spreading out from PHC.

3. RESULTS AND DISCUSSION

The aim of this study is to analyse accessibility to healthcare facilities in Giwa and Tofa local government areas respectively in Kaduna and Kano States of North western Nigeria. This was achieved through the following GIS techniques:

- A database for the healthcare facilities in the areas was created to determine service areas around the healthcare facilities and analyse accessibility in the LGAs.
- Network and Neighborhood Analyses were employed to identify areas of the LGAs that are poorly served and which are well served in terms of their primary health care. The analyses were used to determine access for different census areas (wards), which provides the basis for further analyses. The respective service area was obtained on the basis of travelling distance through the road network as shown in Fig. 3.
- The shortest distance between each origin and destination point was also estimated.

In addition, questionnaire survey was used to complement the results of the GIS analyses. Responses from the survey revealed that most of those who patronise the healthcare centres are women and children, while many men of 25 – 45 years also visit the centres. However, only a few people of old age (60 years and above) come to the centres. In addition, it was found that majority of those who patronise the hospital have some level of formal education mostly primary school and are comparatively economically better up in the society. Therefore, they can afford the medical expenses. Other findings of the study are presented in the sections that follow.

Table 1 showed the gross inequality in the distribution of healthcare facilities in Giwa local government area of Kaduna State, Nigeria. Based on the Nigerian health healthcare standard, there is the need for 16 primary healthcare centres to cater for the people of Giwa instead of the available 3PHCs, and 2 additional general hospitals as well as more health centres or dispensaries. Also, Table 1 reveals uneven distribution of healthcare facilities in the area, whereby, areas such as Kidandan, Galadimawa and Kakangi are grossly underserved while Giwa (the local government headquartes) and Shika (adjoining the LG headquarters) are adequately served. This is a reflection of unfair distribution of facilities between LG capitals and the hinterlands.

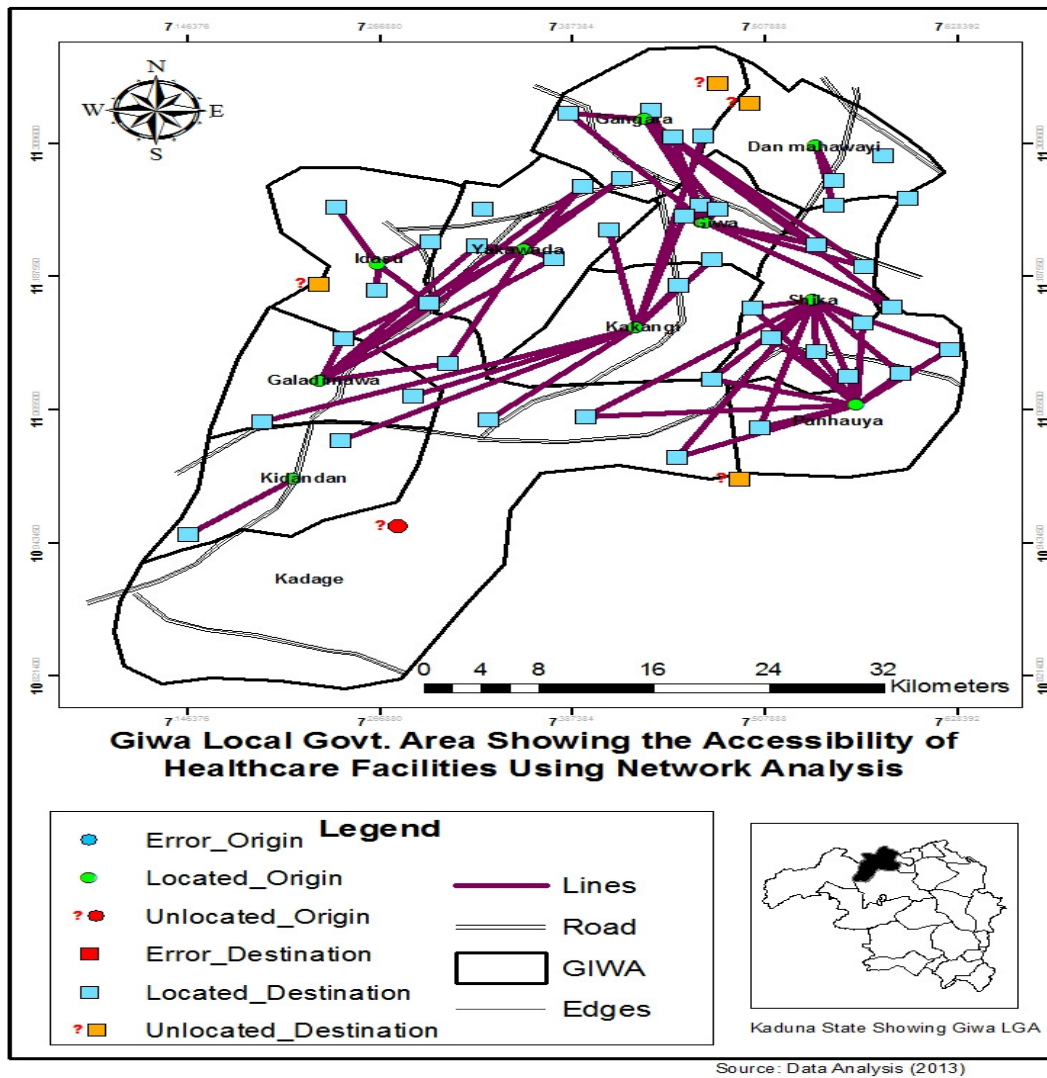


Fig. 3. Network analysis for accessibility to healthcare facilities in Giwa

Table 1. Analysis of the distribution of healthcare facilities in Giwa LGA

S/N	Wards	Population	Available healthcare centres	Required healthcare centres
1	Giwa	63014	3 HC/D; 1GH	3PHC, 1GH
2	Shika	54135	9 HC/D; 1 PHC	3PHC, 1GH
3	Gangara	34371	6 HC/D	2PHC, 1GH
4	Yakawada	29216	5 HC/D	2PHC
5	Idasu	22914	6 HC/D	1PHC
6	Kidandan	21768	2 HC/D	10HC, 1PHC
7	Galadimawa	20050	2 HC/D; 1PHC	10HC, 1PHC
8	Kakangi	13748	1 HC/D	7HC
9	Dan mahawayi	12030	3 HC/D	6HC
10	Panhauya	8593	4 HC/D; 1PHC	4HC
11	Kadage	6588	3 HC/D	3HC

Acronyms: HC: Health Centre, D: Dispensary, PHC: Primary Healthcare Centre, GH: General Hospital

The network analyst tool was used to create OD matrix and service areas. The electoral wards were used as origins and the healthcare facilities as destinations. The origin to destination matrix was imported into a relational database for analysis so that the closest facility to each electoral ward could be identified as shown in Table 2.

Table 2. OD cost matrix analysis of healthcare facilities in Giwa

S/No	Wards	Population	Minimum distance to the nearest facility (in metres)	Maximum distance to the nearest facility (in metres)
1	Gangara	63014	2, 748	25, 560
2	Kadage	54135	9, 320	9,530
3	Panhauya	34371	1, 684	23, 852
4	Giwa	29216	1, 251	15, 128
5	Kidandan	22914	9, 108	9, 108
6	Galadimawa	21768	3, 792	28, 911
7	Kakangi	20050	8, 213	31, 351
8	Idasu	13748	799	2, 834
9	Dan mahawayi	12030	3, 167	5, 466
10	Shika	8593	955	18, 055
11	Yakawada	6588	433	14, 699

The minimum distance to the nearest facility from the OD cost matrix is 433 and the maximum distance is 31, 351 as shown in Table 2. A look at the distance suggest that communities in Kakangi, Galadimawa and Panhauya have serious problem accessing the nearest health facility as they have to travel 24-30km to access some of them. This is outrageous, because a distance of 5km, which is equivalent to one hour walking, is considered to be the maximum radius for PHC [18]. Others have defined the distance of 1 km from the village centre as easy access [19]. In the case Kidandan and Kakangi as shown in II, the nearest health facility is accessed after travelling 9km or 8km respectively. Also, Fig. 4 showed the gross inequality in the distribution of healthcare facilities in Giwa.

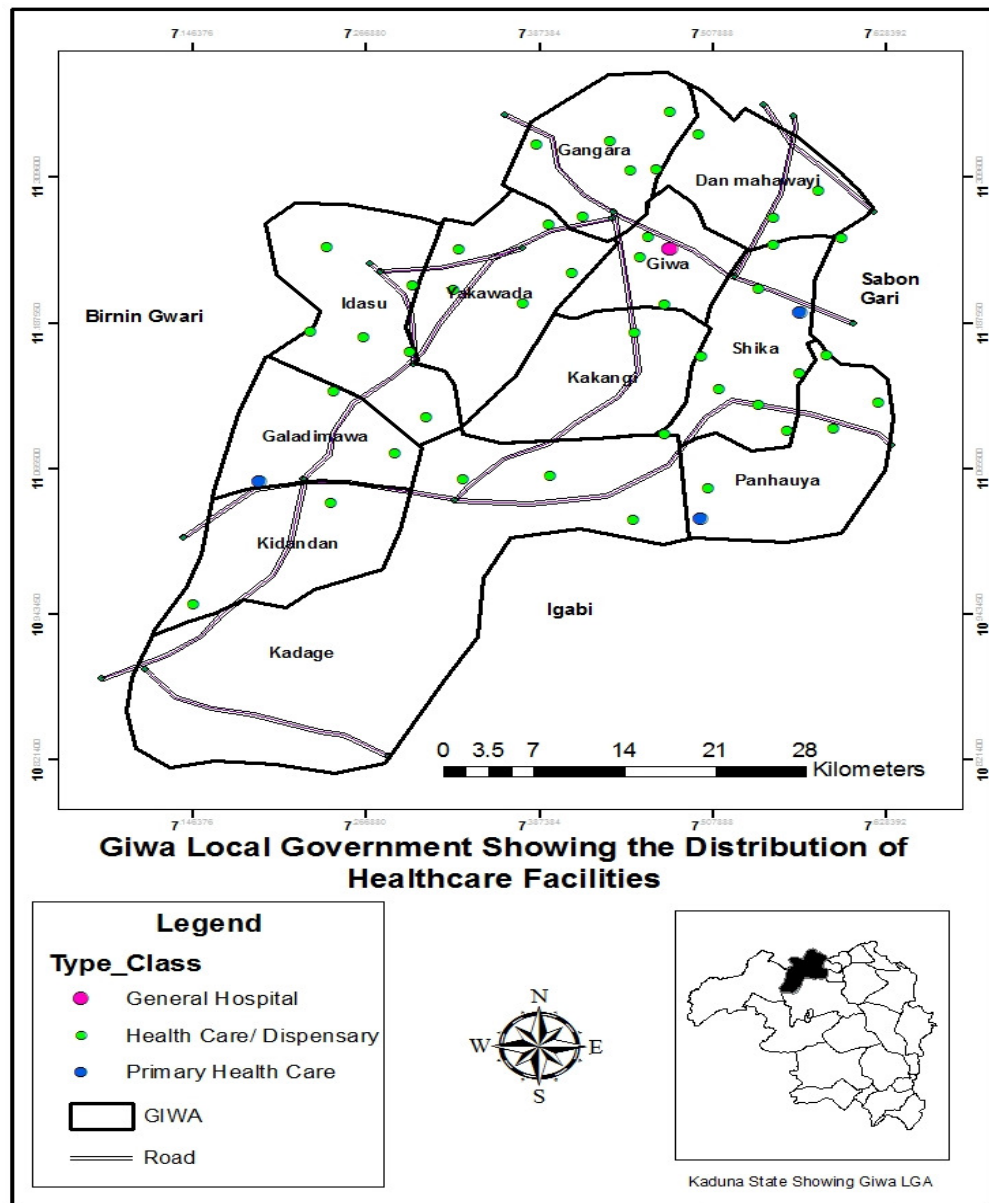


Fig. 4. Distribution of healthcare facilities in Giwa local government area

In rural areas such as Giwa, walking distance to health facilities is an important factor, because of the lack of good transport network whereby many of the roads are not motorable. This has implication on the economy of the area considering the fact that majority are farmers and some of the time due for farming is spent accessing healthcare facilities. It was found from the questionnaire survey that distance is a great barrier to accessing the healthcare facilities, while some of the respondents complained of inadequate facilities, expensive drugs especially in the general hospital.

3.1 Average Nearest Neighbourhood Analysis

This was done to identify geographical pattern of the distribution of health facilities in the study areas. The locational pattern of the health facilities in both Giwa and Tofa local government areas is randomly dispersed as shown by the Average Nearest Neighbour analysis in Fig. 5.

However, Table 3 below showed that Tofa local government area has more health centres than any other healthcare facility in the area.

Table 3. Analysis of the distribution of healthcare facilities in Tofa LGA

S/N	Wards	Population	Available healthcare centres	Required healthcare centres
1	Dindere	1479	1HP	1HC
2	Gajida	4403	1D	2HC
3	TOFA	22027	2CHCC, 1CHC	1HC, 1PHC
4	Wangara	6292	1HP	3HC
5	Yanoko	6669	3HP	3HC
6	Yelwa	2300	1HP	1HC
7	Yarimawa	4395	1HP	2HC
8	Jobe	3358	1HP	2HC
9	Kwami	989	1HP, 1MPH	1HC
10	Unguan Rimi	8906	1HP	4HC
11	Lengel	5991	1HP	3HC
12	Janguza	8968	1D, 1CI	4HC
13	Ginsawa	3296	1HP	2HC
14	Doka	12005	1D, 1HP	6HC
15	Lambu	10848	1BHC, 1MPHCC	5HC

Acronyms: HP: Health Post, CI: Clinic, BHC: Basic Health Centre, CHC: Comprehensive Health Centre, CHCC: Comprehensive Healthcare Centre, MPH: Multipurpose Healthcare, MPHCC: Multipurpose Healthcare Centre

Also, Fig. 6 showed Tofa local government area is dominated by health centres which provide basic healthcare; there is dire need to upgrade them to at primary healthcare centres. It is also observed that the wards at the extreme south of Tofa are more underserved than the other parts. With a population of over 36,000, the area is served by 3 Health Posts, 2 Dispensaries and 1Clinic. Based on the Nigerian health healthcare standard, there is the need for more health centres as well as primary healthcare centres to cater for the people of the area.

The results of the OD cost matrix as shown in Table 4 indicates that Dindere, Lengel and Yelwa are areas with the lowest degree of accessibility as they travel a range of 8 – 12km to access some of the nearest health facilities. These correspond to areas bordering other local government areas and very far from the local government headquarters. This suggests that accessibility to healthcare facilities decrease with increasing distance from the local government headquatres. This is observed from the results of the network analysis for accessibility to healthcare facilities in Tofa as displayed in Fig. 7.

The locational pattern of the health facilities in both Giwa and Tofa local government areas is randomly dispersed as shown by the Average Nearest Neighbour analysis in Table 5 and Fig. 8.

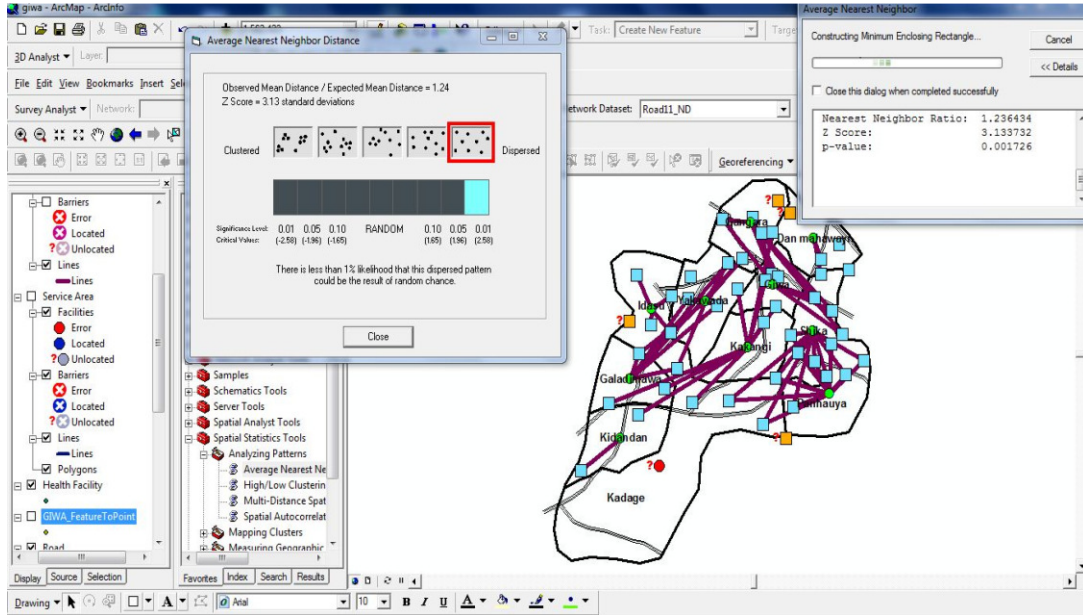


Fig. 5. Nearest neighbourhood analysis for Giwa LGA

Table 4. OD cost matrix analysis of healthcare facilities in Tofa LGA

S/N	Wards	Population	Minimum distance to the nearest facility (in metres)	Maximum distance to the nearest facility (in metres)
1	Dindere	1479	492	12357
2	Gajida	4403	552	13877
3	TOFA	22027	230	1012
4	Wangara	6292	1728	6626
5	Yanoko	6669	1453	3059
6	Yelwa	2300	6626	8231
7	Yarimawa	4395	469	11213
8	Jobe	3358	2824	8767
9	Kwami	989	286	1197
10	Unguwan Rimi	8906	695	1086
11	Lengel	5991	3907	8805
12	Janguza	8968	710	1156
13	Ginsawa	3296	2599	4158
14	Doka	12005	192	1167
15	Lambu	10848	9439	12768

Table 5. Nearest neighbourhood analysis for Tofa LGA

Parameter	Values
No. of health facilities	23
Nearest Neighbour Ratio	1.269515
Z score value	2.418388
p – value	0.015589

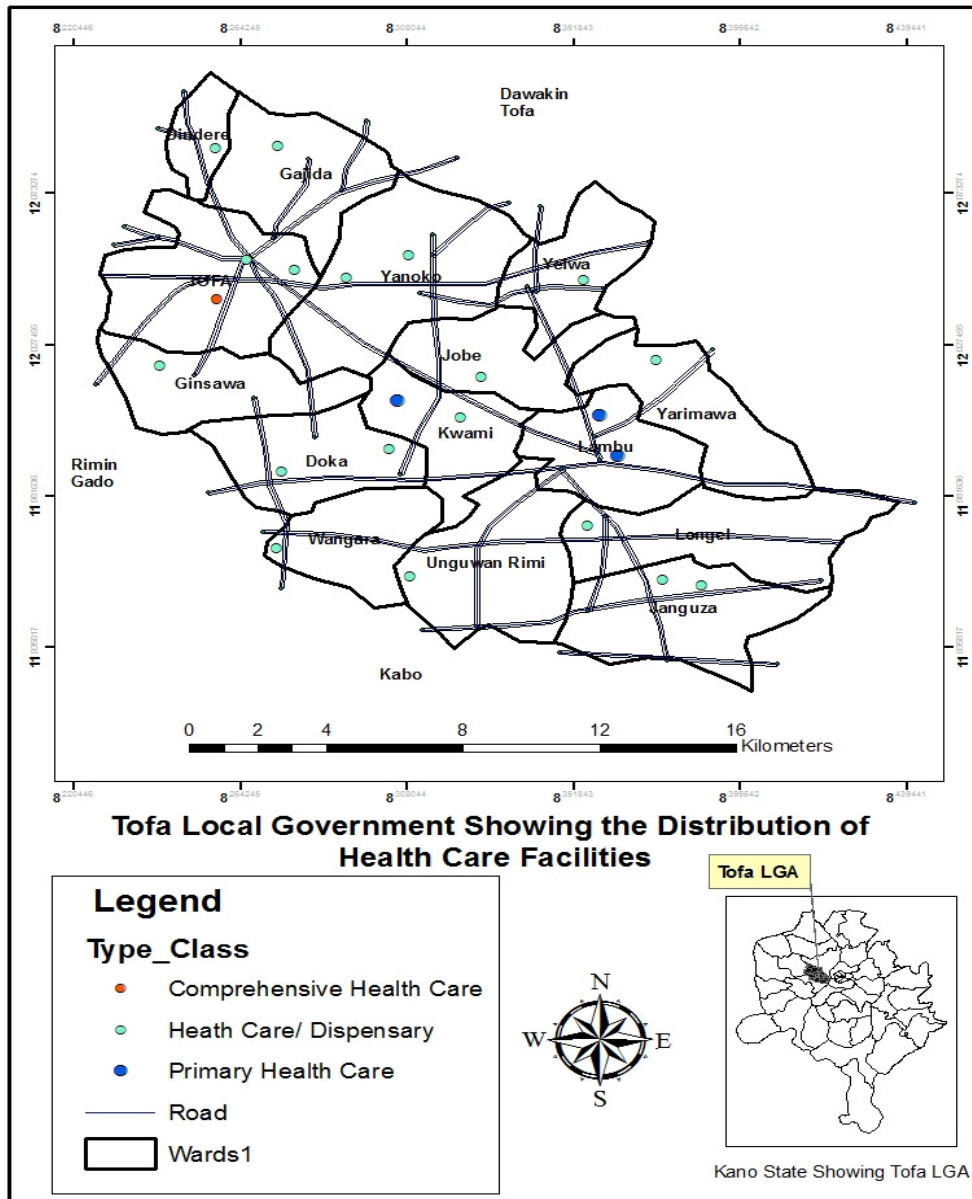


Fig. 6. Distribution of healthcare facilities in Tofa local government area

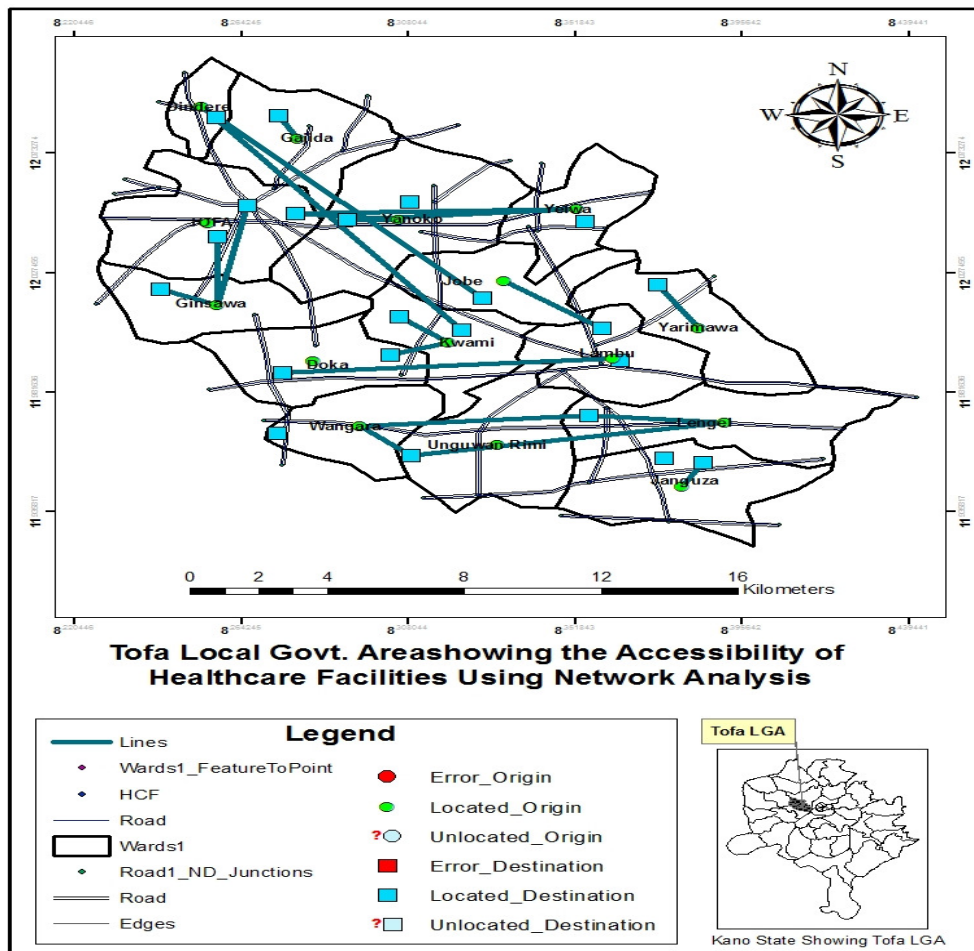


Fig. 7. Network analysis for accessibility to healthcare facilities in Tofa

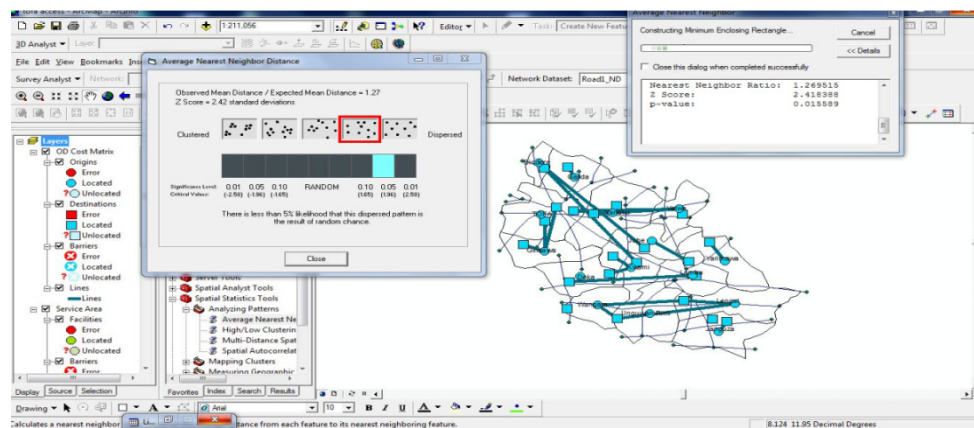


Fig. 8. Nearest neighbour analysis for Tofa LGA

4. CONCLUSION

This study employed GIS techniques to analyse accessibility to healthcare facilities in Giwa and Tofa local government areas of north western Nigeria. Findings revealed inequality in the distribution of healthcare facilities in Giwa LGA, whereby areas in the north eastern part (Idasu, Kidandan, Galadimawa and Kakangi) bordering other LGAs are more underserved compared to the other areas. It was also observed that the wards at the extreme southwest of Tofa (Janguza, Unguwan Rimi, Wangara and Doka) are more underserved than the other parts. With a population of over 36,000, the area is served by 3 Health Posts, 2 Dispensaries and 1 Clinic.

The results of the network analysis indicates that communities in Kakangi, Galadimawa and Panhauya of Giwa LGA have serious problem accessing the nearest health facility as they have to travel 24-30km to access some of them. While communities in Dindere, Lengel and Yelwa of Tofa LGA live in areas with the lowest degree of accessibility as they travel a range of 8 – 12km to access some of the nearest health facilities. These correspond to areas bordering other local government areas and very far from the local government headquarters. This suggests that accessibility to healthcare facilities decrease with increasing distance from the local government headquarters.

It was found that Giwa (the local government headquarters) and Shika (adjoining the LG headquarters) are relatively adequately served just as Tofa (the local government headquarters) and Yanoko (nearest neighbour to the LG headquarters). This is a reflection of unfair distribution of facilities between LG capitals and the hinterlands.

In order to achieve the objective of the National Health Policy, provision of adequate healthcare facilities in rural areas is necessary but accessibility should be regarded as a very fundamental issue. Also the number of facilities provided should be proportional to the population size of the area. In addition, there is a need to establish more general hospitals in the hinterlands away from the local government headquarters to improve access to better healthcare across the entire local government areas. Moreover, government should provide more staff, enough medical facilities and subsidised drugs to facilitate and improve accessibility in the healthcare centres.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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