ASSESSMENT OF ACCESSIBILITY CHALLENGES TO HEALTHCARE FACILITIES USING GEOSPATIAL TECHNOLOGY IN GIWA LOCAL GOVERNMENT AREA, KADUNA STATE

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Abstract

Health constitutes a significant aspect of human capital, and there is considerable consensus in the literature regarding the correlation between health and economic development. This study assessed the accessibility challenges to healthcare facilities in Giwa Local Government Area, Kaduna State. A list of healthcare facilities was obtained from the Health Department of Giwa local government area, while coordinates of the healthcare facilities were collected using a handheld GPS device. Analysis was carried out using descriptive statistics and Average Nearest Neighbor using ArcGIS 10.5. The result shows that a total number of 81 healthcare facilities were identified, where Giwa has the highest with 10 healthcare facilities in the area and a ratio of 1:7620. The average nearest neighbour revealed that the pattern of the spatial distribution of healthcare facilities was clustered with the nearest neighbour ratio of 0.710865, with a z-score of -4.9474 and a p-value <0.05. This research conclusively shows that there is inequality in the distribution of healthcare centres in the wards that make up the study area as population was not considered in the distribution of these facilities resulting in a clustered pattern of distribution of facilities in some areas at the expense of other areas leading to difficulty in reaching facilities. The study therefore recommended there is a need to consider the disadvantaged areas for future location rather than concentrating attention only on a few political districts.

Keywords: *Healthcare Facilities, Accessibility, Average Nearest Neighbour, Spatial Distribution, and Giwa Local Government Area.*

Introduction

Health is a major form of human capital and there exists substantial agreement in the literature on the relationship between health and economic development through its relationship between capability and poverty (Yang *et al*., 2022). Globally, substantial advancements in healthcare delivery have been uneven, with a focus on improving services in certain regions (Okeke *et al*., 2023). Thus, understanding the influence of healthcare access on life expectancy across nations is essential for shaping global health strategies (Galvani-Townsend *et al*., 2022). It is assumed that improvement in health leads to improvements in life expectancy, which is a strong indicator of human development (Lawanson & Umar, 2021). Empirical evidence has shown that among poor countries, an increase in

life expectancy is strongly correlated with an increase in productivity and income (Alhassan *et al*., 2021).

The healthcare delivery system comprises the organization of individuals, institutions, and resources to offer healthcare services that address the health requirements of a specific population, ranging from a solo practitioner to an extensive healthcare system (Piña *et al*., 2015). These systems vary from one country to another, whereas in some countries, health care is provided in a three-tiered system, wherein the government finances and oversees only the two higher levels of services district health centres and hospitals (Heller & Hsiao, 2017). In Nigeria, the government is responsible for the establishment and management of primary healthcare (PHC) facilities under the National Primary Health Care Development Agency (NPHCDA) (Aregbeshola & Khan, 2017). The PHCs are tasked with the provision of basic care which is mostly free, however, 70% to 90% of Nigerians still finance their healthcare through out-of-pocket (OOP) expenditure (Akinwumi *et al*., 2022; Alawode & Adewole, 2021).

Measuring accessibility to healthcare facilities is very important, especially in determining their distribution efficiency and their spatial suitability for residential neighbourhoods (Taran, 2023). Accessibility, in general terms, describes the degree to which a system is usable by as many people as possible. However, Gould (1969) believed accessibility is a slippery notion and one of those common terms that everyone uses until faced with the problem of defining and measuring it. Thus, it is the degree of ease with which to reach certain locations from other locations and is viewed as the ability to access functionality and possible benefits (Abbas *et al*., 2014). Studies have revealed that adequate access to healthcare in Nigeria is very limited in all dimensions due to factors within and beyond the health system (Abah, 2023). More so, there are serious complaints about accessibility to the services and the poor services rendered to people (Nwokoro *et al*., 2022). There are also problems with the introduction of user fees for services provided, the unfriendly opening hours, poor skill of other staff and the absence of drugs (Sule *et al*., 2008).

This gap identified made the study of the spatial spread of primary health centres necessary, looking at how accessibility problem affects the level of utilization of the health facilities in the area of study. Geographical access to healthcare facilities is known to influence health service usage (Otu, 2018). Primary health care guarantees that patients receive high-quality, all-encompassing care as close to their daily surroundings as possible. According to the World Health Organization (WHO, 2023a), this care includes promotion and prevention, treatment, rehabilitation, and palliative care. Recent advancements in the field of Geography have greatly improved our understanding of the role played by the spatial distribution of public services in meeting the needs of the population (Baba *et al*., 2020; Mohammed *et al*., 2024).

Literature Review

Nigeria has one of the highest maternal and newborn mortality rates globally, with more than 40,000 maternal fatalities annually (Abdussalam *et al*., 2023). Nigeria's short life expectancy is partly attributable to the highest mortality rates among children aged five and under compared to any other nation globally (Abubakar *et al*., 2022). A fast-expanding population, accompanied by a lack of reliable access to high-quality healthcare, schooling, and other essential services will serve only to raise the likelihood of protests, drive large-scale unintended emigration, and subsequent local and even global instability (Abubakar *et al*., 2022).

Healthcare has been incorporated into the United Nations' Sustainable Development Goals (SDGs). Specifically, Goal 3 of the SDGs promotes healthy lives and promote well-being for all ages (WHO, 2023c). However, inequality in access to healthcare is still a significant problem in developing nations. For example, the World Bank evaluated this argument in all its ramifications when it said that "many people in Nigeria especially those who live in the northern region have a health status that is on many different measures, not as good as those who live in the southern regions" (Akeredolu, 2018). Beyond the direct repercussions on education, and health, Nigeria's increasing population carries with it a variety of other health challenges (Adesola *et al*., 2024).

Previous studies have shown that there is a comparatively higher concentration of health care in urban regions and less in rural ones (Kibon & Ahmed, 2013). Rural and distant populations commute longer distances and spend longer travelling when they require specialists rather than general medical attention (Mseke *et al*., 2024). As a result, the World Health Organization recognized the importance of economic distance in the distribution of health infrastructure back in 2007. The WHO (2023b) subsequently recommended a walking radius for different categories of healthcare facilities with 16 kilometres for hospitals, 0-8 kilometres for maternity and clinics, and 0-4 km for dispensaries.

Materials and Methods

Study Area

Giwa Local Government Area (LGA) is between Latitude 10º49' 44.43" and 11º24'30.40" north of the Equator, and between Longitude 7º05' 56.77" and 7º37' 51 east of the Greenwich Meridian as shown in Figure 1. Giwa is located in the northern part of Kaduna state and has a tropical Savanna climate (*Aw*) characterized by alternating wet and dry conditions (Abubakar *et al*., 2024). The dry season runs from October to April of the next year, while the rainy season runs from April through mid-October, peaking in August, with an average rainfall of 1032 mm. According to the 2006 census by the National Population Commission, Giwa LGA had a 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, 712m above sea level. Giwa represents a multicultural city on the Savanna of northwestern Nigeria where several ethnic groups (Isma'il *et al*., 2014).

Sources of Data

A list of healthcare facilities was obtained from the Health Department of Giwa LGA. Coordinates of the healthcare facilities were obtained using a handheld GPS device. The road network datasets and the administrative boundary map were downloaded from Geo-Referenced Infrastructure and Demographic Data for Development (GRID3 - Nigeria, 2024), while population data was obtained from the National Population Commission (NPC) and Kaduna Bureau of Statistics (2015).
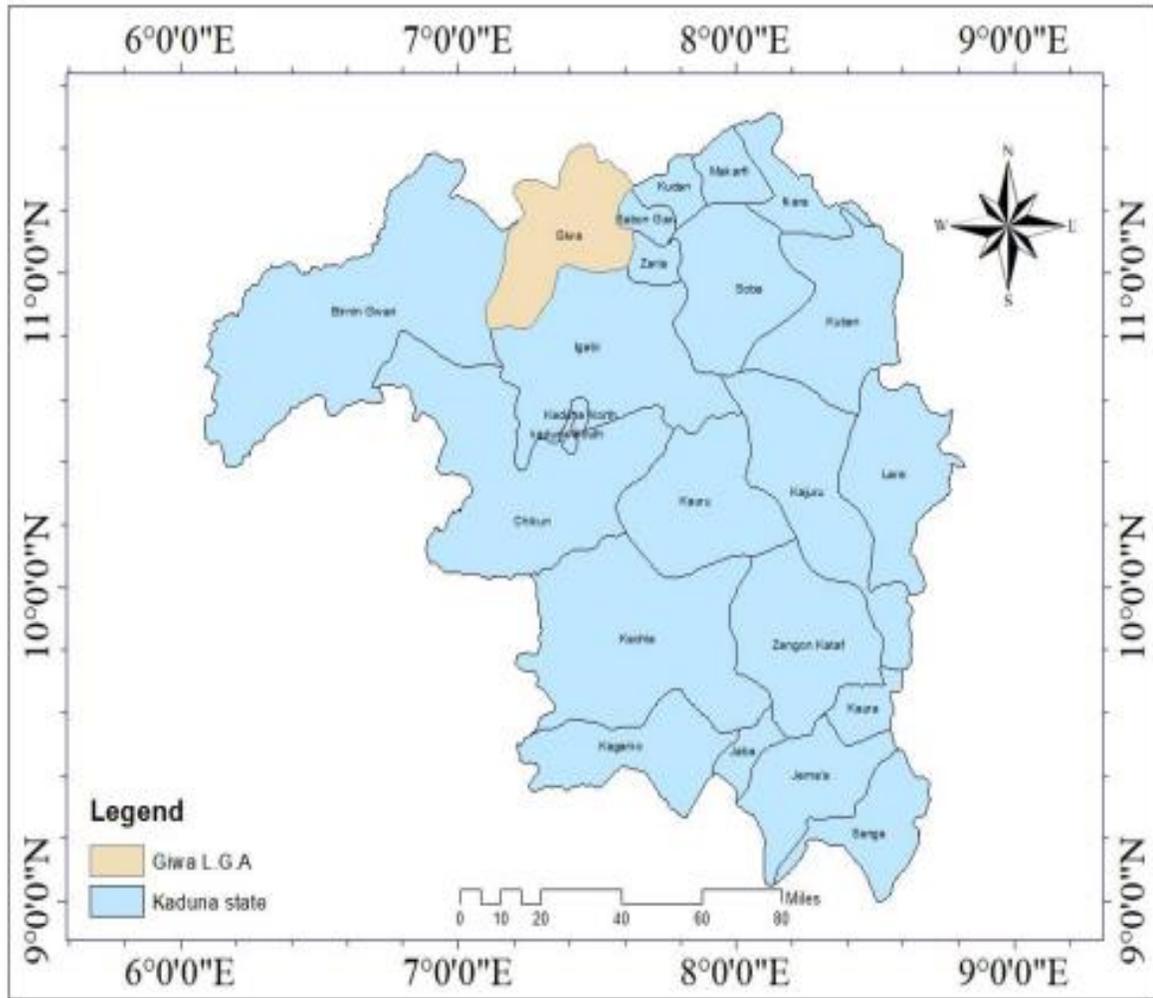
Figure 1: Kaduna State Showing Giwa Local Government Area

Data Analysis

A combination of descriptive and overlay analysis was employed in the analysis of the data where simple analytical techniques were used to analyze appropriate maps/diagrams and tables to illustrate the distribution of healthcare centres in the study area and the use of simple percentages to summarize findings. Furthermore, to identify and map healthcare facilities in the study area, the attributes of each healthcare facility were used to identify each facility in the study area. With the aid of a handheld GPS receiver, the actual coordinates of each facility were captured. The coordinates and other attributes of the healthcare facilities were then copied to Microsoft Excel and saved in CSV (comma delimited) format, and then imported into ArcGIS 10.5 using the add XY tool and saved as shape files (.shp). The shape files created were used to carry out Average Nearest Neighborhood Analysis using ArcGIS 10.5. This provided the expected and observed distance, z-score and p-value of primary healthcare centres in Giwa LGA.

$$ANN = \frac{D_o}{D_E}$$

Where D_O is the observed mean distance between each feature and its nearest neighbour.

$$D_O = \frac{\sum_{i=1}^{n} d_i}{n}$$

D_E is the expected mean distance for the features given in a random pattern:

$$D_o = \frac{0.5}{\sqrt{n/A}}$$

In the above equations, di equals the distance between feature i and its nearest neighbouring feature. n corresponds to the total number of features, and A is the area of a minimum enclosing rectangle around all features, or it's a user-specified Area value.

The average nearest neighbour z-score for the statistic is calculated as:

$$z = \frac{D_O - D_E}{SE}$$

Where

$$SE = \frac{0.26136}{\sqrt{n^2/A}}$$

If the index (average nearest neighbour ratio) is less than 1, the pattern exhibits clustering. If the index is greater than 1, the trend is toward dispersion.

Results and Discussions

Distribution of Healthcare Facilities in Giwa Local Government Area

This study identified the existing healthcare centres across the 11 wards of Giwa local government area. The result is shown in Table 1.

Table 1: Distribution of Healthcare Centers in Giwa Local Government Area

S/N	Ward	No. of Healthcare Facilities	Percentage	Population	Ratio
1	Danmahawayi	6	7%	34762	1:5794
2	Galadimawa	5	6%	23847	1:4769
3	Gangara	6	7%	56302	1:9384
4	Giwa	10	12%	76200	1:7620
5	Idasu	8	10%	19149	1:2394
6	Kakangi	8	10%	21165	1:2646
7	Kidandan	8	10%	21014	1:2627
8	Panhauya	5	6%	31549	1:6310
9	Shika	9	11%	69773	1:7753
10	Wazata	8	10%	12345	1:1543
11	Yakawada	8	10%	28594	1:3574
	Total	**81**	**100%**	**394700**	

Table 1 revealed that Giwa ward had the highest number with a total of 10 (12%) of the healthcare facilities. Shika had 9 (11%), while Idasu, Kakangi, Kidandan, Wazata and Yakawada had 8 healthcare facilities each. Danmahawayi and Gangara wards have 6 healthcare facilities each, while Galadimawa and Panhauya have 5 healthcare facilities each. This agrees with the findings of Abbas *et al*. (2014) that there is an uneven distribution of healthcare facilities in some local government areas of Kaduna State. This result is shown in Figure 2.
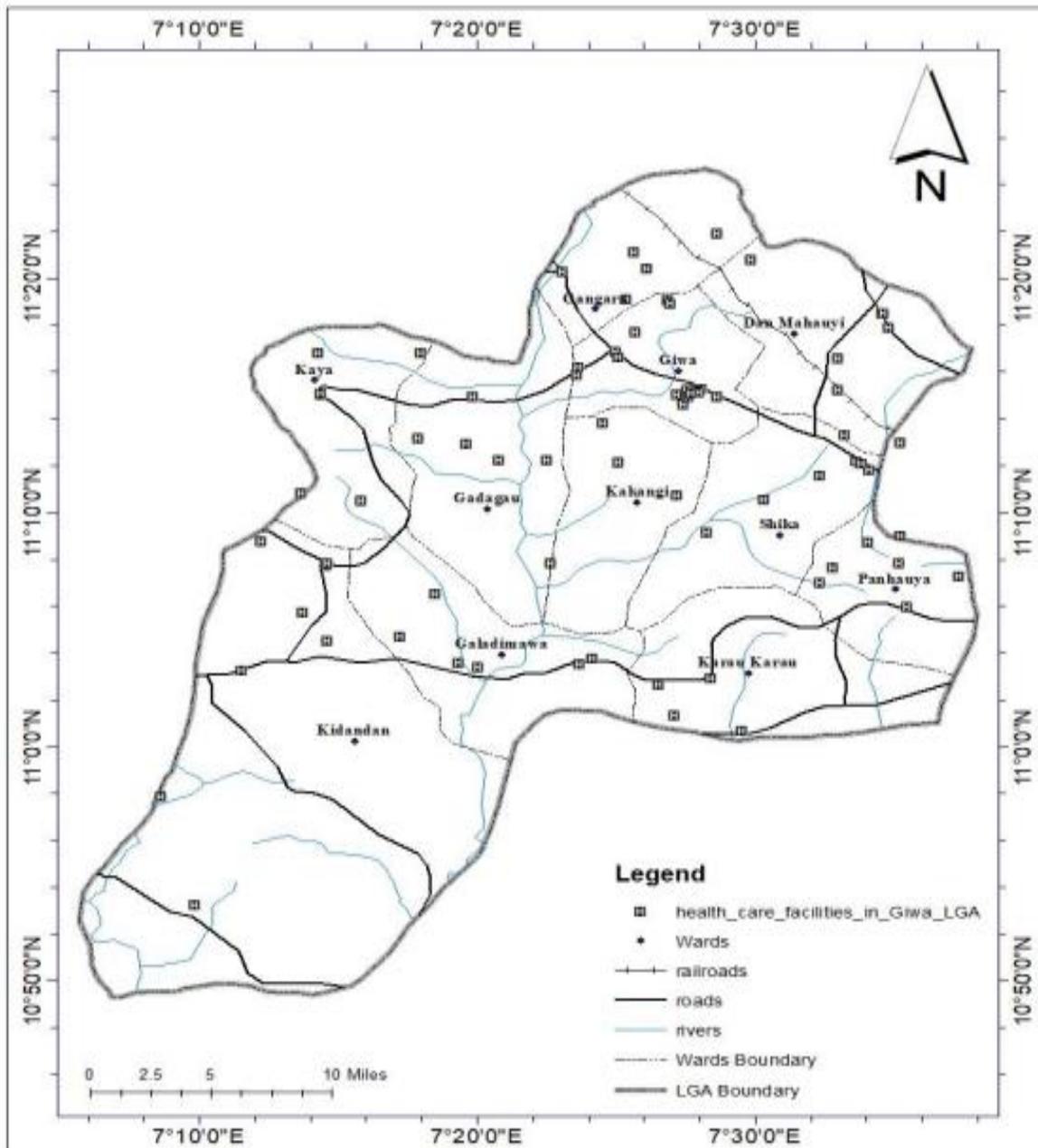

Figure 2: Spatial Distribution of Healthcare Facilities across Political Wards in Giwa LGA

Distribution of Medical Doctors across the Wards in Giwa Local Government Area

The number of medical doctors available across each ward in Giwa LGA was examined. The result is shown in Table 2.

Table 2: Distribution of Medical Doctors across the Wards in Giwa LGA

S/N	Ward	No. of Doctors	Percentage
1	Danmahawayi	0	0%
2	Galadimawa	0	0%
3	Gangara	0	0%
4	Giwa	4	6%
5	Idasu	0	0%
6	Kakangi	5	8%
7	Kidandan	1	2%
8	Panhauya	0	0%
9	Shika	49	79%
10	Wazata	0	0%
11	Yakawada	3	5%
	Total	**62**	**100%**

Table 2 revealed that only 5 out of the 11 wards enjoy the services of a medical doctor, with the Shika ward having 49 (79%) medical doctors available in the area. Kakangi ward is immediately behind with 5 (8%) doctors, Giwa ward has 3 medical doctors which accounted for 6% of doctors, and Yakawada ward has 4 (5%) medical doctors. Lastly, Kidandan had the lowest with 1 (2%) of the medical doctors in the LGA. This is similar to the findings of Obubu *et al*. (2023) that there is a variation in the distribution of healthcare personnel between urban and rural areas.

The distribution of healthcare facilities with medical doctors as well as those without the services of medical doctors in the area is shown in Figure 3. Based on the Nigerian healthcare standard, there is a need for more health centres as well as primary healthcare centres to cater for the people of the area (Isma'il *et al*., 2014).
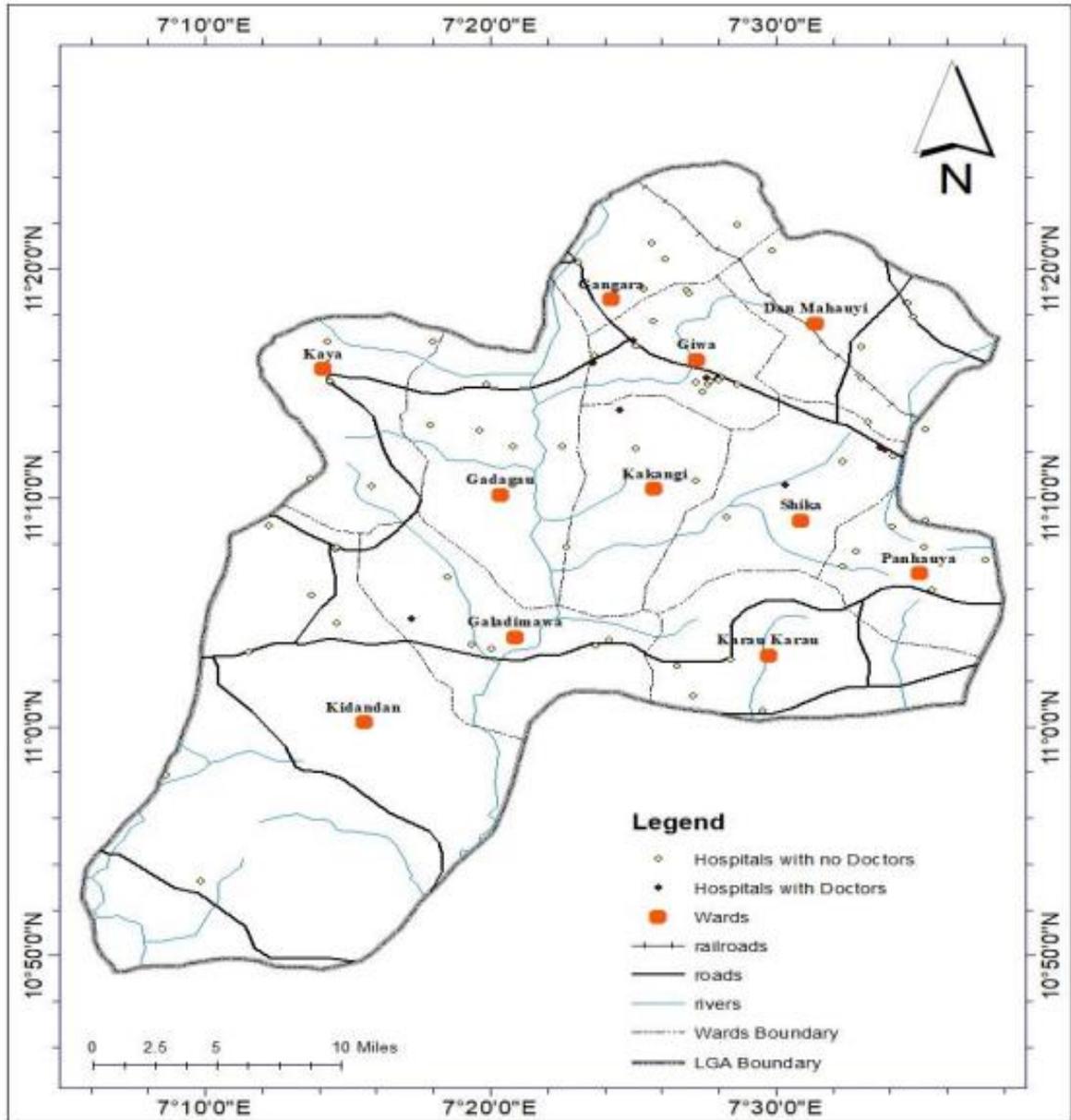
Figure 3: Healthcare Facility with and without Doctors in Giwa Local Government Area

Spatial Pattern of Distribution of Healthcare Centers in Giwa Local Government Area

This study examined the pattern of spatial distribution of healthcare facilities in Giwa LGA of Kaduna State. The result is shown in Table 3 and Figure 4.

Table 3: Average Nearest Neighbor

Observed Mean Distance (m)	Expected Mean Distance (m)	Nearest Neighbor Ratio	Z-score	P-Value
3020.5	4249.1	0.710865	-4.9474	0.000001

Table 3 revealed that the expected mean distance (4249.1 m) was higher than the observed mean distance (3020.5 m). Given the nearest neighbour ratio of 0.710865, with a z-score of -4.9474 and a p-value <0.05, there is a less than 1% likelihood that this clustered pattern could result from random chance. This result disagrees with the findings of Averik *et al*. (2023) which revealed that healthcare facilities in Giwa LGA were dispersed, although their study focused on primary healthcare facilities only.
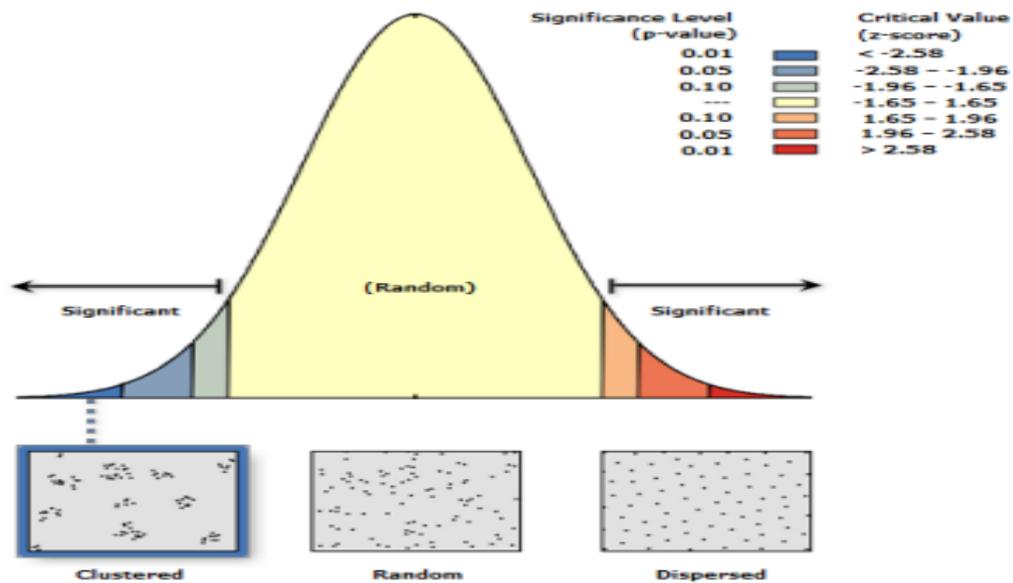
This result is illustrated in Figure 4.

Figure 4: Spatial Pattern of Healthcare Facilities in Giwa Local Government Area

The clustered nature of the spatial pattern of distribution is an indication that the healthcare facilities are more concentrated in certain locations, and fewer in other locations, confirming the lopsided nature of their distribution. Thus, this result confirms the findings of Kibon and Ahmed (2013) that healthcare facilities are more concentrated in urban centres compared to areas on the outskirts.

Conclusion

This research evaluated the accessibility challenges to healthcare facilities in Giwa local government area, Kaduna state, using spatial analysis methods. The results indicate a notable imbalance in the allocation of healthcare facilities, exhibiting a clustered pattern that is inconsistent with population distribution. Although Giwa ward has the highest density of healthcare services, other regions encounter accessibility difficulties stemming from an inequitable distribution of resources. The average nearest-neighbour analysis confirmed that the spatial distribution of healthcare institutions is clustered, hence intensifying challenges in accessing healthcare services. These findings underscore the necessity for a more equitable allocation of hospital infrastructure, taking into account population density and accessibility to enhance healthcare service delivery. Rectifying this disparity will improve healthcare accessibility, reduce inequalities, and eventually foster superior health outcomes in the region. Hence, there is a need to consider the disadvantaged areas for future location rather than concentrating attention only on a few political districts.

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