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Research Article

Geospatial Assessment of the Distribution and Accessibility of Healthcare Facilities in Kaduna South Local Government Area

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ABSTRACT

This study conducted a geospatial assessment of the distribution, accessibility, and functionality of healthcare facilities in Kaduna South Local Government Area, Kaduna State, Nigeria. The objectives were to analyze the spatial distribution pattern of healthcare facilities, determine their categories and ownership, and assess accessibility across different wards. Data were obtained from the Kaduna State Ministry of Health and the Kaduna South LGA Health Department, while facility coordinates were captured using a handheld GPS device. Descriptive statistics, Average Nearest Neighbor analysis, and an Origin-Destination Cost Matrix were employed to analyze distribution characteristics, spatial patterns, and travel-time accessibility, respectively. The findings revealed a spatially uneven and inequitable distribution of healthcare facilities, with a concentration in central wards such as Tudun Wada and Barnawa and a scarcity in peripheral areas such as Badiko and Unguwan Sanusi. Although the Average Nearest Neighbor ratio (NNR=0.99, p=0.93) indicated a statistically random pattern, the observed clustering in urban centers created underserved "healthcare deserts" at the periphery. The healthcare system is dominated by primary (52.0%) and secondary (46.7%) facilities, with only one tertiary facility (1.3%), and a near-equal distribution between private (52%) and public (48%) ownership, highlighting a heavy reliance on the private sector. Accessibility analysis revealed significant travel-time disparities, with central wards having rapid access (0.15 minutes) and peripheral wards such as Badiko experiencing the longest travel times (2.6 minutes). The study concludes that healthcare distribution in Kaduna South LGA is spatially imbalanced, structurally limited at higher levels of care, and inequitable in terms of accessibility. It recommends establishing new facilities in underserved wards, upgrading existing healthcare infrastructure, regulating private healthcare services, and improving transport networks to enhance equitable access to healthcare.

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1 Introduction

Health is a fundamental human right, and the accessibility of hospital facilities plays a critical role in determining the overall well-being of populations. Hospitals are central in providing curative, preventive, and emergency services, making their equitable distribution a major determinant of healthcare outcomes (Abah, 2023). Also, healthcare systems worldwide are structured to ensure equitable access to health facilities for all individuals, regardless of their socio-economic background. The World Health Organization (WHO) emphasizes that equitable distribution and accessibility of hospitals are critical to achieving Universal Health Coverage (WHO, 2023). In developing countries such as Nigeria, rapid population growth, unplanned urbanization, and inadequate planning mechanisms often result in uneven distribution of hospitals, leaving some areas over-served. In contrast, others remain underserved (Adesola et al., 2024). This challenge is particularly evident in Nigeria, where health outcomes continue to lag behind global targets despite the expansion of the healthcare network (Oleribe et al., 2019).

The spatial arrangement of healthcare facilities is not only a question of availability but also of accessibility, which is influenced by distance, transportation networks, travel time, and socio-economic conditions (Amoah-Nuamah et al., 2023). Studies have shown that populations living in areas with poor spatial accessibility to hospitals experience higher levels of maternal and infant mortality, reduced immunization coverage, and delayed emergency response (Balsa-Barreiro et al., 2025; Umar et al., 2025). Globally, GIS has become an indispensable tool for assessing and improving hospital distribution. Scholars have applied GIS to identify healthcare gaps, optimize facility siting, and model travel-time accessibility in both developed and developing contexts (Lawal & Anyiam, 2019; Nsiah et al., 2024). In sub-Saharan Africa, where urban expansion often outpaces infrastructure provision, GIS provides evidence-based insights that support efficient allocation of scarce health resources (Ahmed et al., 2021).

Nigeria presents a unique case, as the healthcare system is a three-tier structure comprising primary, secondary, and tertiary facilities. While primary health centers are widespread, hospitals providing secondary

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and tertiary care are fewer and often concentrated in urban centers (Akinwumi et al., 2022). This uneven distribution results in overcrowding in some hospitals and underutilization in others, thereby undermining the efficiency and equity of healthcare delivery (Ishaq et al., 2024).

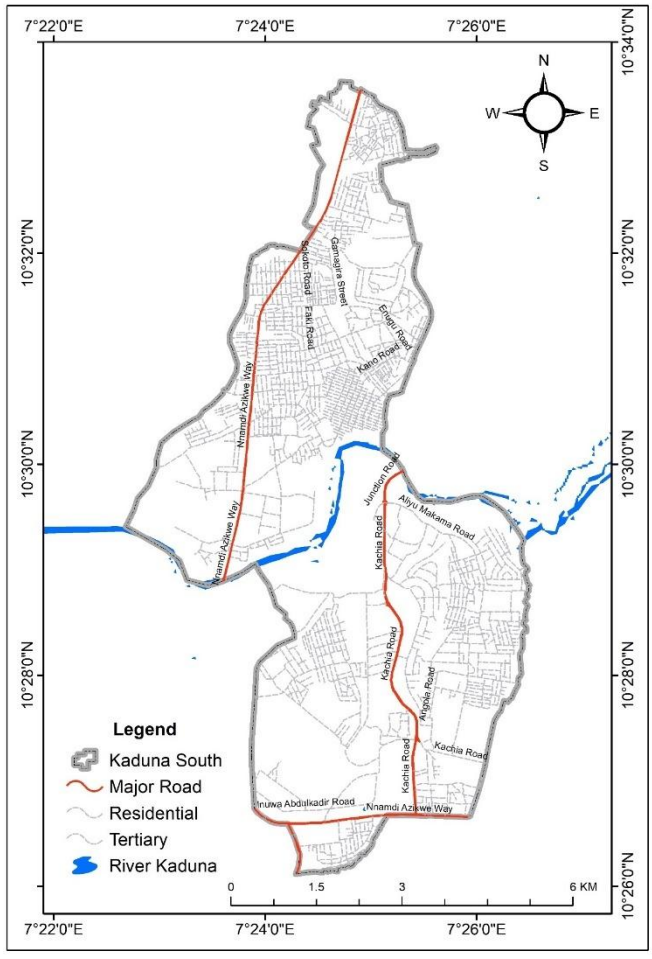
Kaduna State, one of the most urbanized regions in Northern Nigeria, is characterized by an increasing demand for health services driven by urban expansion and demographic pressure. Kaduna South Local Government Area (LGA), located within Kaduna Metropolis, is highly diverse in land use and socio-economic activities. However, preliminary evidence suggests that healthcare facilities in Kaduna South are concentrated in certain wards and along major road corridors, leaving peripheral, densely populated, low-income areas inadequately served (Averik et al., 2024, 2023). This spatial imbalance affects timely access to healthcare, especially in emergencies, and may exacerbate health inequalities among residents (Mohammed et al., 2025). Beyond issues of spatial location, the availability of qualified medical personnel and functional equipment remains uncertain, with some facilities reportedly understaffed or poorly equipped (Abdussalam et al., 2024). These challenges raise critical questions about both the physical accessibility and service readiness of healthcare facilities within the LGA. Given the increasing pressure on healthcare delivery in Kaduna South, there is a critical need for a geospatial assessment of hospital distribution to identify coverage gaps, assess accessibility levels, and propose strategies to achieve equitable healthcare provision. This study, therefore, seeks to fill this gap by leveraging GIS techniques to provide spatially informed insights that will guide effective health planning in Kaduna South LGA.

2 Materials and Methods

2.1 Study Area

Kaduna South LGA is one of the metropolitan LGAs in Kaduna State, Nigeria. It is located approximately between latitude 10° 26′ 47″ N and 10° 34′ 05″ N, and longitude 7° 24′ 50″ E and 7° 25′ 16″ E (Figure 1). The LGA is highly urbanized, with a mix of residential, commercial, and industrial land uses. It has a dense population and is served by both public and private healthcare facilities. Kaduna South Local Government Area (LGA), like the wider Kaduna metropolis, lies within the Basement Complex geology of Northern Nigeria (Jibril et al., 2024). In terms of relief, Kaduna South LGA generally exhibits a gentle undulating topography, with elevations ranging from about 600 to 650 meters above sea level (Musa & Abubakar, 2024). The terrain is not rugged, which enhances accessibility and makes the construction of roads and health facilities easier. However, low-lying areas in parts of the LGA are prone to waterlogging and localized flooding, especially during the rainy season (Abubakar et al., 2025).

The drainage system of Kaduna South is largely influenced by the River Kaduna, which flows across the metropolis from the northeast to the southwest. Several smaller seasonal streams and tributaries also drain the area, particularly during the rainy season between April and October (Abubakar et al., 2025). These drainage channels play a vital role in groundwater recharge and water supply, but are often subject to encroachment, waste dumping, and silting, which can impact environmental health. Inadequate drainage infrastructure in densely populated areas of Kaduna South also contributes to periodic flooding, which can hinder accessibility to healthcare facilities and pose public health risks (Bununu et al., 2015).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Ibrahim Taiwo Road
Ranchers Bee Road
Kaduna Polytechnic Road
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Sokoto Road
Fatu Road
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402,731 persons, with a fairly balanced distribution between males (204,458) and females (198,273) (NPC, 2006). Recent projections, based on the national average annual growth rate of 3.2%, estimate that the population of Kaduna South LGA will exceed 600,000 by 2022 (Kaduna Bureau of Statistics, 2015). The population of Kaduna South is mainly urban, given its location within the Kaduna metropolis. Settlement density is high, with both formal housing estates and informal settlements scattered across the LGA. Communities such as Makera, Kakuri, Tudun Wada, Barnawa, and Television are among the most densely settled areas (Ojonuba et al., 2025).

2.2 Reconnaissance Survey

As a preparatory step for the study, a reconnaissance survey was conducted to familiarize the researcher with the study area. The objective was to obtain available relevant information on healthcare facilities and establish a cordial working relationship with relevant stakeholders.

2.3 Types and sources of data

i. Coordinates of the healthcare facilities were obtained using the handheld Global Positioning System (GPS) Garmin GPSmap 76S receiver.
ii. Attribute data of the identified healthcare facility were sourced from the various healthcare facility management systems by inventory using a checklist. The data include the healthcare facility name, ward/location, category, and ownership.
iii. Administrative map of the study area.
iv. Road network datasets were obtained from GRID3 Nigeria.

2.4 Data Analysis

2.4.1 Identification and mapping of healthcare facilities in Kaduna South

The healthcare facilities were identified, and the field-obtained coordinates were entered into Microsoft Excel. The required number of fields (i.e., columns) was then added to the table, and the data for all healthcare facilities were entered in their corresponding records (i.e., rows). The coordinates were then imported into the GIS environment and overlaid on the administrative map to show the distribution of the healthcare facilities in the study area.

Subsequently, the Nearest Neighbour Analysis, an inferential statistical tool in ArcGIS 10.8, was used to determine the dispersion pattern, clustering, or randomness of the healthcare facilities. The Z-score, which typically ranges from -2.58 to 2.58, was also obtained to assess the level of healthcare facilities. The nearest neighbour analysis is calculated as

$$ANN = \frac{D_o}{D_E} \quad (i)$$

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

$$D_O = \frac{\sum_{i=1}^{n} d_i}{n} \quad (ii)$$

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

$$D_o = \frac{0.5}{\sqrt{n/A}} \quad (iii)$$

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

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

$$z = \frac{D_O - D_E}{SE} \quad (iv)$$

Where

$$SE = \frac{0.26136}{\sqrt{n^2/A}} \quad (v)$$

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.

2.4.2 Categorization of healthcare facilities in Kaduna South

To categorize healthcare facilities in Kaduna South LGA, the facilities in the attribute table were sorted by ward (location), facility level (primary, secondary, or tertiary), and ownership (private or public). Subsequently, the Pivot Table on Microsoft Excel was used to summarize the facilities. Descriptive statistics were used to sum the frequencies and calculate the percentages.

2.4.3 Spatial accessibility of healthcare facilities in Kaduna South

To achieve this objective, random points were generated to represent the centroids of wards within their boundaries, and the average distance (travel time from each ward to each healthcare facility along the road network) was calculated using the Network Analyst functionality in ArcGIS 10.8. This involves using the Origin-Destination Matrix (OD) analyst tool. This tool is

useful for representing a matrix of vehicular travel times (distances) from a set of origin locations (wards) to a set of destination locations (healthcare facilities). The travel times were calculated assuming travel by car at a standard speed (e.g., 30-40 km/h) on the road network. The distance between each ward centroid and all healthcare facilities was further structured into a geodatabase to determine the distance in kilometers from each ward to each healthcare facility in Kaduna South.

3 Results and Discussion

3.1 Location of Healthcare Facilities in Kaduna South LGA

The spatial analysis of healthcare facilities in Kaduna South LGA, detailed in Figure 2, uncovers a distinct pattern of central clustering and peripheral scarcity. The findings indicate that healthcare infrastructure is not uniformly distributed but is instead heavily concentrated in high-density urban cores. The highest densities are observed in the centrally located wards of Tudun Wada North and South, Sabon Gari Kakuri, and Barnawa. This pattern can likely be attributed to several socio-economic factors: these areas are historic commercial centers with higher household incomes, better road networks, and greater demand for private health services, making them economically attractive locations for healthcare providers.

In contrast, wards like Badikko and Unguwan Sanusi are characterized by a markedly lower concentration of facilities. This spatial inequity suggests that residents of these areas may face significant barriers to accessing primary healthcare, including longer travel distances, higher transportation costs, and potentially longer waiting times at the fewer available facilities. The identified pattern raises critical concerns about health equity and underscores the need for targeted policy interventions to address the service gaps in these underserved wards.

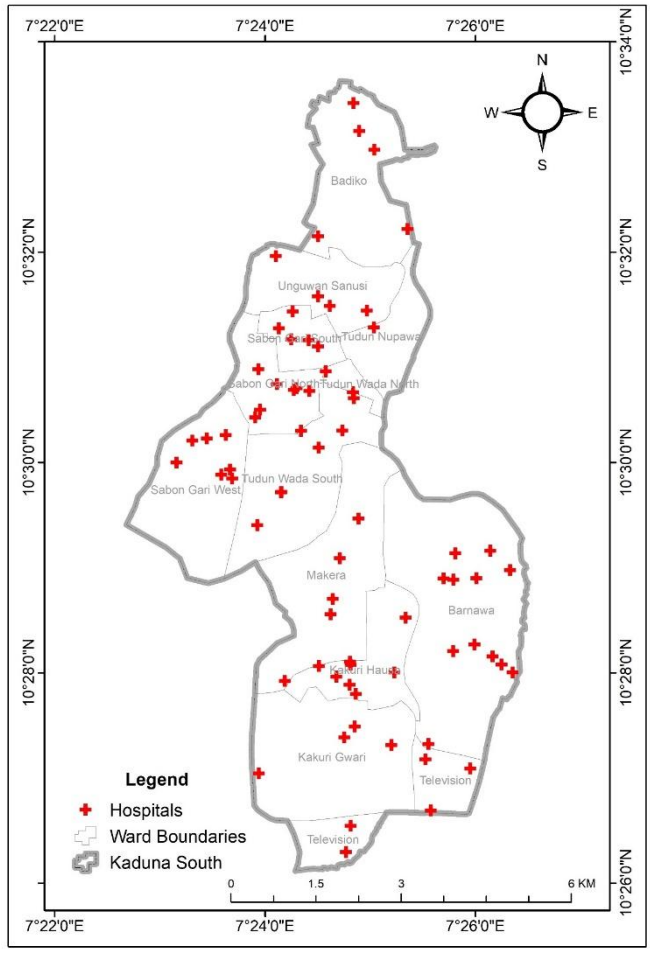

Figure 1: Location of healthcare facilities in Kaduna South Local Government Area

3.2 Pattern of Spatial Distribution of Healthcare Facilities in Kaduna South LGA

Table 1 shows the spatial distribution pattern of healthcare facilities in Kaduna South Local Government Area.

Table 1: Average Nearest Neighbor Summary

Observed Mean Distance	Expected Mean Distance	Nearest Neighbour Ratio	z-score	p-value
495.13 Meters	497.94 Meters	0.99	-0.09	0.93

Table 1 revealed that the Nearest Neighbor Ratio (NNR) is 0.99. This value is exceptionally close to 1.0, the value that defines a perfectly random spatial distribution. The average distance between each facility and its closest neighbor (495.13 meters) is virtually identical to the average distance that would be expected if the same number of facilities were randomly scattered across the Kaduna South LGA (497.94 meters). This interpretation of randomness is statistically confirmed by the high p-value of 0.93 and the very low z-score of -0.09.

The p-value, far above the common significance threshold of 0.05, indicates that the slight difference between the observed and expected distances is not statistically significant and is highly likely due to chance. The z-score, which represents how many standard deviations the observed result is from the expected value, is very close to zero, further reinforcing the absence of meaningful clustering or dispersion in the point pattern. Figure 3 illustrates this result.

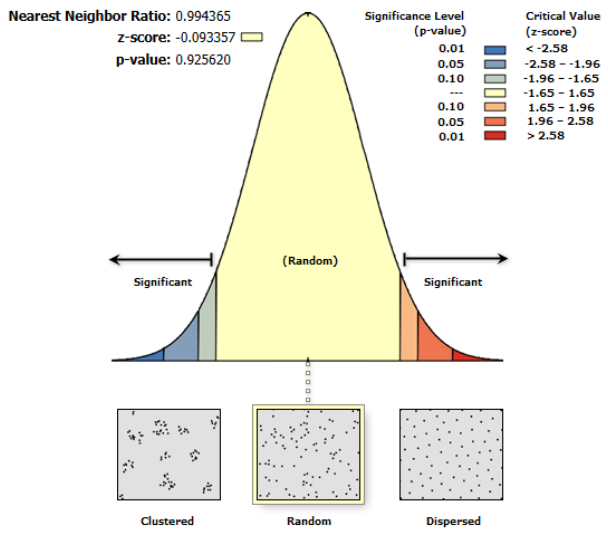

Figure 2: Average Nearest Neighbor Analysis

3.3 Categories of Healthcare Facilities in Kaduna South LGA

The study examined the categories of healthcare facilities in Kaduna South Local Government Area based on their wards, ownership (public or privately owned), and facility level (primary, secondary, or tertiary).

3.3.1 Distribution of Healthcare Facilities by Wards

Table 2 presents the distribution of healthcare facilities in Kaduna South Local Government Area by political wards.

Table 2: Distribution of Healthcare Facilities by Wards

Ward	Frequency	Percentage
Badiko	5	6.7
Barnawa	15	20.0
Kakuri Gwari	3	4.0
Kakuri Hausa	7	9.3
Makera	7	9.3
Sabon Gari North	5	6.7
Sabon Gari South	7	9.3
Sabon Gari West	6	8.0
Television	5	6.7
Tudun Nupawa	2	2.7
Tudun Wada North	3	4.0
Tudun Wada South	6	8.0
Unguwar Sanusi	4	5.3
Total	**75**	**100.0**

Table 2 presents the distribution of healthcare facilities across the wards of Kaduna South Local Government Area, revealing significant disparities in their spatial allocation. Barnawa ward stands out as the primary hub, with the highest number of facilities (15), constituting a substantial 20.0% of the total 75 facilities. In contrast, the distribution is highly uneven, as several wards are severely underserved. For instance, Tudun Nupawa has only two facilities (2.7%), while Kakuri Gwari and Tudun Wada North each have just three (4.0%). This concentration, where just one ward accounts for a fifth of all resources, indicates a clear inequity in physical access to healthcare, with services heavily centralized in Barnawa and leaving other wards like Badiko, Sabon Gari North, and Television with much lower shares (6.7% each). This result is illustrated in Figure 4.

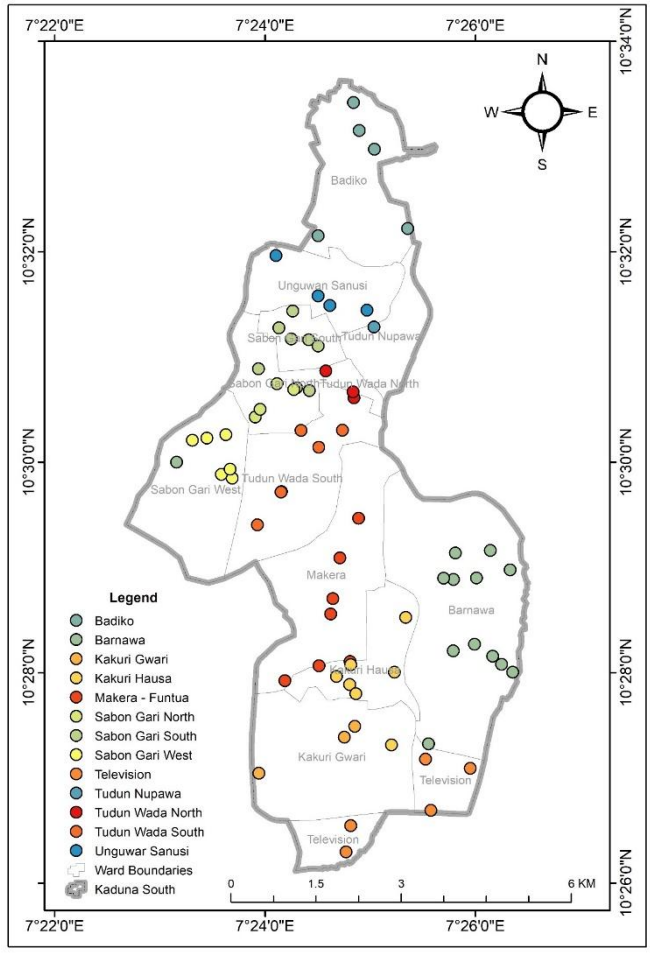

Figure 3: Distribution of healthcare facilities by wards

3.3.2 Distribution of Healthcare Facilities by Facility Level

Table 3 and Figure 5 present the distribution of healthcare facilities in Kaduna South Local Government Area by facility level.

Table 3: Distribution of healthcare facilities by facility level

Facility Level	Frequency	Percentage
Primary	39	52.0
Secondary	35	46.7
Tertiary	1	1.3
Total	76	100.0

Table 3 revealed the tiered structure of the healthcare system in the studied area by categorizing its 71 facilities into primary, secondary, and tertiary levels. The data reveal a system overwhelmingly composed of primary and secondary care facilities. Primary-level facilities, which provide basic and preventive care, form the foundation of the system, constituting 52.0% (39 facilities). They are closely matched by secondary-level facilities, which offer more specialized services and inpatient care, at 46.7% (35 facilities). This near-equal distribution suggests a network with a strong capacity for handling both routine health needs and more complex medical cases at the local and regional level.

However, a critical gap is evident at the highest level of care. The system includes only a single tertiary facility, representing a mere 1.3% of the total. Tertiary care institutions are essential for providing advanced, highly specialized treatment, complex surgery, and advanced diagnostic services. The near absence of this tier indicates a significant limitation within the local healthcare infrastructure. Consequently, patients requiring sophisticated medical interventions, such as advanced neurosurgery or cancer treatment, would almost certainly need to be transferred to a major urban center outside the region, potentially creating access barriers and delays in critical care. Figure 5 illustrates this result.

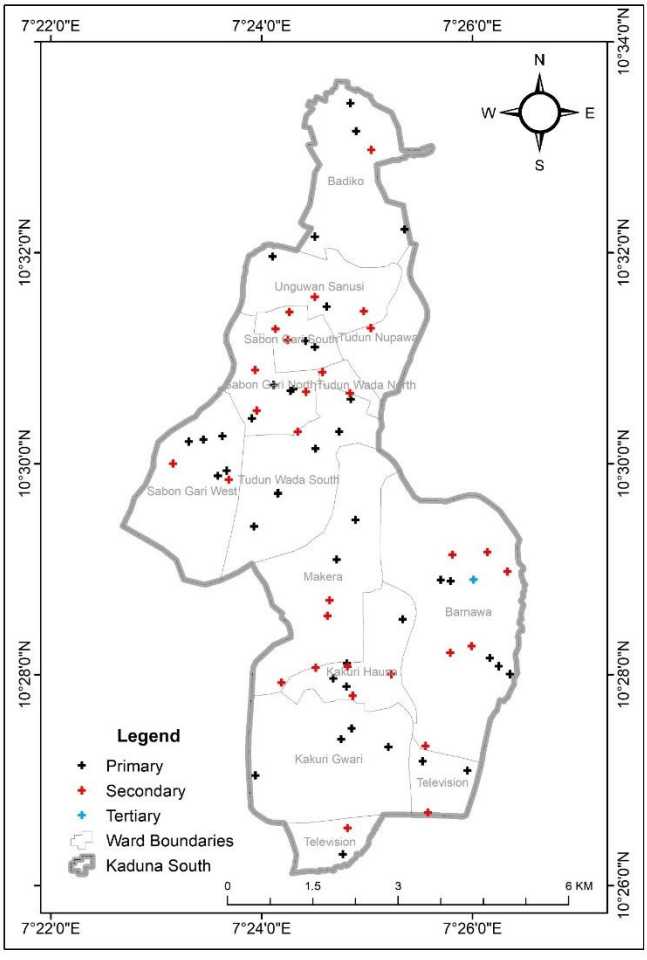

Figure 4: Distribution of healthcare facilities by facility level

3.3.3 Distribution of Healthcare Facilities by Ownership

Table 4 and Figure 6 present the distribution of healthcare facilities in Kaduna South Local Government Area by ownership.

Table 4: Distribution of healthcare facilities by ownership

Ownership	Frequency	Percentage
Private	39	52.0
Public	36	48.0
Total	75	100.0

Table 4 categorizes the 75 healthcare facilities in the studied area by their ownership, revealing a nearly even split between private and public providers. The data shows that private entities operate the slight majority of facilities, accounting for 52.0% (39 facilities), while public ownership covers 48.0% (36 facilities). This indicates a significant reliance on the private sector for healthcare delivery within the region, with the two sectors contributing almost equally to the total infrastructure.

The near-parity between private and public ownership has important implications for the healthcare landscape. On the one hand, the strong private-sector presence suggests a robust market for healthcare services, potentially offering patients more choices and fostering innovation. On the other hand, this balance highlights a substantial reliance on non-state actors, which can pose challenges in regulating service quality and costs. Furthermore, it raises questions about equitable access, as private facilities may be concentrated in more profitable, urban areas, while the public sector is often responsible for serving harder-to-reach or lower-income populations. This distribution underscores the need for strong government policy and coordination to ensure that the overall healthcare system remains comprehensive, affordable, and accessible to all residents. This result is illustrated in Figure 6.

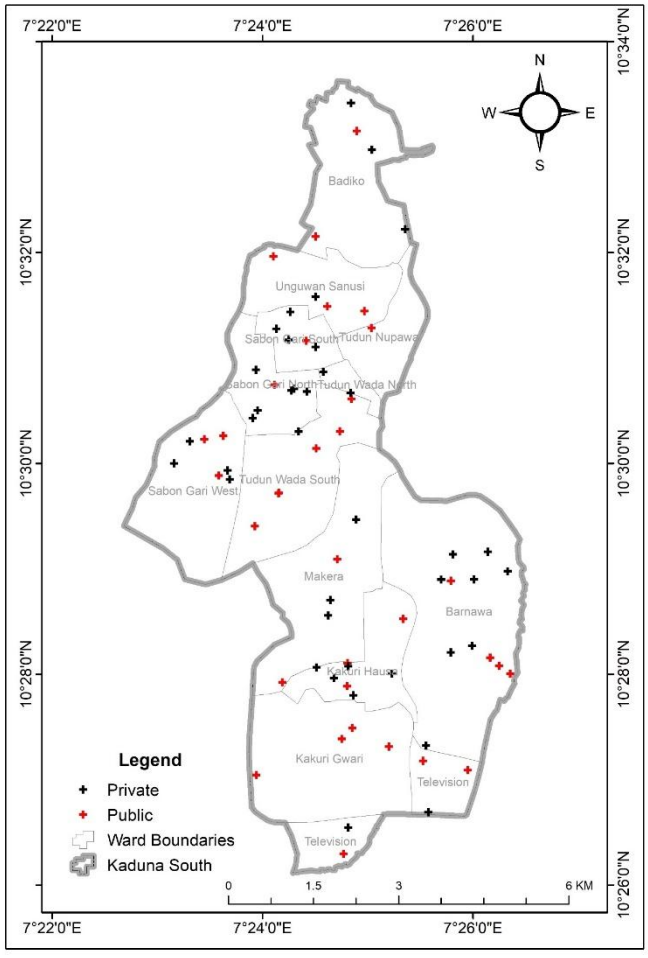

Figure 5: Distribution of healthcare facilities by ownership

3.4 Accessibility to Healthcare Facilities in Kaduna South LGA

The study revealed a clear spatial divide between central urban wards (e.g., Sabon Gari North, Tudun Wada North) and peripheral wards (e.g., Badiko, Kakuri Gwari). The study also revealed a severe disparity in the distribution of healthcare facilities. The travel time from Badiko to its closest facility (2.6 minutes) is over 8 times longer than from Sabon Gari North (0.15 minutes). From a policy perspective, Badiko is a clear priority for intervention. The results also revealed that wards like Barnawa and Tudun Wada are confirmed as healthcare hubs, providing excellent access not only to their own residents but also to surrounding areas. The result is shown in Table 5 and Figure 7.

Table 5: Summary of OD Cost Matrix

Ward Name	Nearest Facility	Travel Time (m)	Distance (m)	Accessibility	Key Observation
Sabon Gari West	Al Amim Hospital	1.08	717	Excellent	10+ facilities within 5 minutes.
Tudun Wada North	Sujud Hospital	0.32	212	Excellent	Best access overall; quickest time to the nearest facility.
Unguwan Sanusi	Saby Hospital	0.39	259	Excellent	Good access with multiple nearby choices.
Sabon Gari South	Kubau Road PHC	0.37	244	Excellent	Very good central access with low travel times.
Sabon Gari North	Kagoro Road Clinic	0.15	103	Excellent	A facility is essentially within walking distance.
Tudun Nupawa	Yusuf Dantsoho	0.75	500	Good	Good access to a major hospital, but slightly longer times.
Makera	Down Quarter PHC	0	0	Excellent	The facility is located within the ward itself
Kakuri Hausa	Maneks Hospital	1.29	857	Good	A cluster of facilities ~1-2 minutes away.
Television	Bengola Hospital	1.36	905	Good	The nearest facility is over 1.3 minutes away.
Barnawa	Barnawa Health Clinic	0.9	600	Excellent	Strong access, serving as a major hub for the area.
Tudun Wada South	Kinkinau PHC	0.51	340	Excellent	Good access within the central cluster of wards.
Kakuri Gwari	K/ Gwari PHC	0.5	332	Good	Fair access, but on the periphery of the central zone.
Badiko	Badikko PHC	2.6	1731	Poor	Longest travel time to the nearest facility.

From Table 5, the results reveal a strong positive correlation between distance (Total_Length in meters) and travel time (Total_Time in minutes). However, the relationship is not perfectly linear due to the road network's characteristics. For residents of Sabon Gari West (OriginID 1), access to healthcare is excellent, with the closest facility, Al Amim Hospital, located just 716 meters away, a 1.08-minute walk. As the distance increases, the travel time predictably rises. For instance, a journey of about 1.2 km to Kabala West Health Clinic takes 1.8 minutes, while a 3.4 km trip to Aitaam Hospital takes just over 5 minutes. This demonstrates that, within the dense urban core, even longer distances yield relatively short travel times, likely due to a well-connected road network. However, a stark contrast is visible when comparing central and peripheral wards. Tudun Wada North (OriginID 2) also enjoys excellent access, with its closest facility, Sujud Hospital, located just 212 meters and 0.32 minutes away.

Meanwhile, the outlying ward of Badiko (OriginID 12) faces a significant accessibility challenge. Its closest facility, Badikko Primary Health Center, is already 1.73 km away, requiring a 2.6-minute journey. For Badiko residents to reach a major hospital like Yusuf Dantsoho General Hospital, they must travel over 3.8 km, which takes 5.7 minutes. This comparison highlights a critical spatial inequity: residents in central wards have multiple options within a few hundred meters and minutes, while those in peripheral wards like Badiko have significantly fewer, more distant choices, fundamentally affecting their access to timely healthcare.

4 Discussion

The results reveal a pronounced spatial inequity in the distribution and accessibility of healthcare facilities within Kaduna South LGA, confirming findings from Nigerian health geography studies that highlight disparities in urban versus peripheral access to healthcare services (Abbas et al., 2014; Mohammed et al., 2025). The concentration of facilities in central wards such as Barnawa and Tudun Wada aligns with patterns observed in Nigerian cities where healthcare infrastructure clusters around commercial and higher-income areas, reflecting economic viability and demand (Adeyemi et al., 2022; Alfa & Aliyuahmadu, 2021).

The finding that the Nearest Neighbor Ratio is close to 1 suggests a random distribution at the macro level, but ward-level analysis reveals significant local clustering, indicating an inequitable distribution (Eta et al., 2021). This underscores the importance of multi-scale spatial analysis in healthcare planning, consistent with insights from regional studies that found random patterns can mask subregional disparities (Abdullahi et al., 2024; Averik et al., 2024).

The dominance of primary and secondary healthcare facilities aligns with Nigeria's health system structure, which emphasizes primary healthcare as the first line of service (I. Abubakar et al., 2022). However, the near absence of tertiary care facilities locally points to constrained availability of specialized services, a rural-urban divide also reported by Cyr et al. (2019) and Shehu (2020), which forces residents requiring advanced care to travel outside the LGA, posing barriers related to cost, time, and health outcomes.

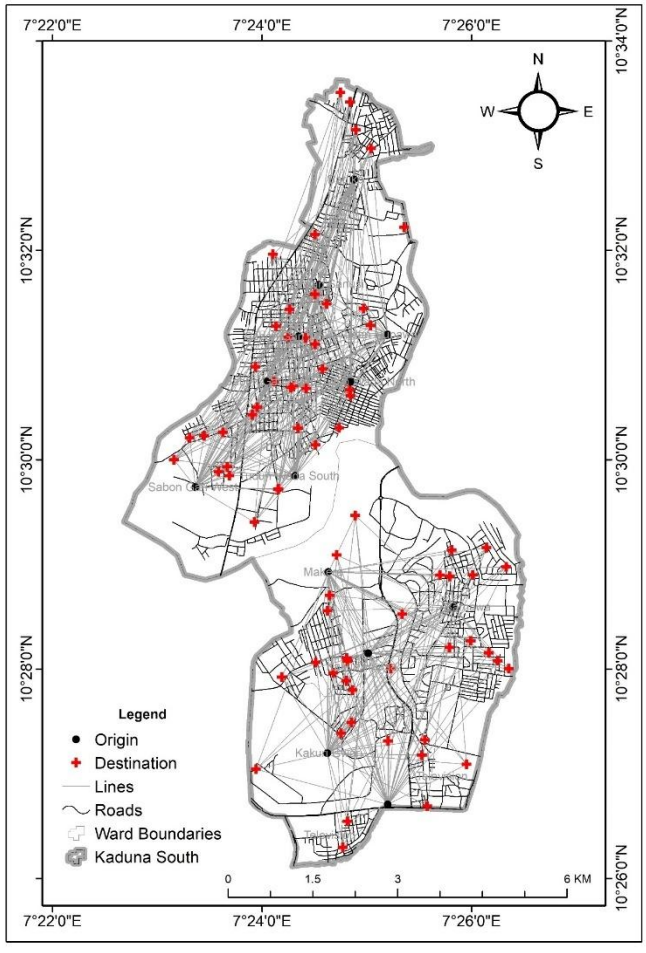

Figure 1: Distribution of healthcare facilities by ownership

The near parity in public versus private ownership reflects Nigeria's mixed healthcare provision but raises policy concerns about regulation, equitable access, and quality control (I. Abubakar et al., 2022). The literature indicates that private facilities often concentrate in urban centers with better-paying clientele, which may exacerbate spatial inequities already evident here (Ishaq et al., 2024).

Accessibility findings, especially travel times, highlight serious challenges for peripheral wards like Badiko, where residents face travel times over eight times longer than those of central ward residents. This corroborates studies of healthcare access in Nigerian urban peripheries that link longer travel times to reduced service utilization and poorer health outcomes (Ahmed et al., 2021; Nnadi et al., 2024). The sharp spatial divide emphasizes the critical

need for targeted interventions in underserved areas through mobile clinics, satellite facilities, or improved transport infrastructure.

In summary, the results echo a growing body of Nigerian health geospatial research that emphasizes spatial inequities in healthcare facility location and access, which disproportionately affect peripheral and lower-income communities. Effective policies need to address the uneven distribution of resources and strengthen healthcare infrastructure in underserved wards, while balancing public and private roles to improve equity, accessibility, and health outcomes for Kaduna South LGA residents.

5 Conclusion

This study has conducted an extensive geographical analysis of the distribution, accessibility, and usefulness of healthcare services in the Kaduna South Local Government Area. The results show significant differences in space, structure, and access that affect the local healthcare scene. Healthcare facilities are not evenly distributed across the city. There are many in central, high-density urban wards like Tudun Wada and Barnawa, but few in peripheral wards like Badiko and Unguwan Sanusi. The Average Nearest Neighbor analysis showed that the distribution was statistically random, but the spatial reality indicates functional clustering in metropolitan cores and underserved healthcare deserts on the edges.

The fact that primary and secondary healthcare institutions are the most common types of healthcare facilities in Kaduna South shows that the area has a strong foundation for basic and intermediate health services. However, the almost complete lack of tertiary facilities reveals a significant structural gap in the healthcare system, forcing patients to be sent outside the LGA for specialized care. The nearly equal split between public and private ownership shows how important yet uneven private providers are in healthcare delivery, raising concerns about the affordability and accessibility of healthcare for people with low incomes. An investigation of accessibility showed, once more, that location has a significant effect on how easy it is to reach healthcare. Central wards have quick access, taking only a few minutes, while neighborhoods on the edges take much longer. This pattern underscores the disparity in healthcare provision, where residents in outlying wards bear a greater burden in accessing medical treatment.

The study finds that the distribution of healthcare facilities in Kaduna South LGA is uneven, has structural limitations at higher levels of care, and is inequitable in terms of access. Based on these findings, the Kaduna State Ministry of Health should: (a) prioritize the establishment of a new primary health center in Badiko ward; (b) develop a regulatory framework for private providers to ensure service standards and fees are equitable; and (c) conduct a feasibility study for upgrading the existing primary health center in [Ward Name] to a secondary facility to reduce the burden on central hospitals.

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