

SPATIAL INEQUALITY IN THE DISTRIBUTION OF HEALTHCARE FACILITIES IN SUB-SAHARAN AFRICAN CAPITAL CITY: A GIS-BASED ASSESSMENT OF ABUJA, NIGERIA.

By

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Abstract

Equitable geographical access to healthcare is an important component of universal health coverage, yet rapid urbanisation can produce substantial inequalities in the location of health infrastructure within cities. This study evaluates the spatial distribution of healthcare facilities in Abuja Municipal Area Council (AMAC), Federal Capital Territory, Nigeria, using Geographic Information Systems (GIS) and spatial analytical techniques. Primary data were obtained through field identification and georeferencing of healthcare facilities, while secondary data included population, administrative and planning information. A questionnaire survey involving 384 residents was also used to examine perceived consequences of the existing distribution pattern. The analysis employed ward-level facility counts, facility-to-population ratios, Nearest Neighbour Analysis, Kernel Density Estimation, Location Quotient, and proximity/buffer analysis. The results reveal a pronounced spatial imbalance. Of the 233 facilities recorded in the ward-level inventory, Gwarimpa contained the largest share (15.9%), followed by City Centre (11.6%), Kabusa (11.2%) and Garki (10.7%); collectively, these four wards accounted for 49.4% of the facilities. In contrast, Karshi and Kanshi contained only 1.7% and 0.9%, respectively. Kernel density analysis identified high-density clusters around Wuse, Garki, Gwarimpa and the Central Area, while Karshi, Kanshi, parts of Orozo and interior Jiwa constituted low-density areas. Location Quotient values ranged from 2.06 in Gwarimpa to 0.11 in Karshi, confirming substantial territorial imbalance. The findings also indicate a pronounced core-periphery accessibility gradient, with residents in peripheral wards facing greater distances to higher-order healthcare services. Survey responses reinforce these findings, particularly regarding emergency response, personnel pressure and increased healthcare costs. The study concludes that healthcare provision in AMAC reflects urban development, infrastructure concentration and market forces more strongly than population-based spatial equity. A GIS-led, needs-responsive planning framework is therefore required to redirect investment towards underserved communities and integrate healthcare provision with ongoing urban expansion.

Keywords: Healthcare facilities; Spatial inequality; Healthcare accessibility; Geographic Information Systems; Urban health; Spatial clustering; Abuja; Nigeria; Location Quotient; Kernel Density Estimation

1.0 Introduction

Healthcare is both a social necessity and a critical component of sustainable urban development. The benefits of healthcare investment extend beyond disease treatment to labour productivity,

household welfare, life expectancy and human development. These benefits, however, depend partly on whether healthcare services are physically available and geographically accessible to the populations that need them. Spatial accessibility is therefore an important dimension of healthcare equity because distance, transport conditions, settlement structure, and the location of service providers influence the ability of individuals to obtain timely care. Evidence from sub-Saharan Africa shows persistent inequalities in geographical access to healthcare, particularly along the urban–rural and core–periphery continuum (Florio et al., 2023). Recent research has further demonstrated that spatial access can vary considerably within cities, depending on socioeconomic conditions and the distribution of healthcare infrastructure (Dumedah et al., 2023).

The spatial distribution of healthcare facilities is consequently an important concern for urban planning and health-system governance. A city may contain a considerable number of hospitals and clinics and yet remain spatially inequitable if facilities are concentrated in particular districts. This distinction between overall availability and equitable spatial coverage is particularly relevant in rapidly growing cities, where population expansion frequently occurs at the urban fringe. As new settlements emerge beyond established service centres, healthcare infrastructure may fail to expand at the same pace. The resulting spatial mismatch can increase travel distances, intensify demand on existing facilities and disadvantage residents with limited financial and transport resources.

Nigeria provides an important setting for examining these issues. Previous studies have demonstrated substantial geographical differences in healthcare facility distribution across the country. Nwakeze and Kandala (2011) identified important spatial differences in the distribution of health establishments, while Makinde et al. (2018) demonstrated substantial inequalities in the distribution of healthcare facilities with implications for universal health coverage. More recent GIS-based research in Nigerian cities has similarly shown that healthcare facilities can be concentrated around urban centres while peripheral locations remain comparatively underserved. In Ibadan, for example, geospatial analysis identified statistically significant health-facility clustering around urban areas, while the distribution outside the built-up area was considerably weaker; the authors argued that such lopsided distribution could produce inequitable access to available services.

Abuja presents a particularly important case because its development history differs from that of many Nigerian cities. As the national capital, Abuja was conceived as a planned city with a hierarchical structure of districts, transportation corridors, administrative centres and residential areas. Subsequent population growth, migration, land development and metropolitan expansion have nevertheless transformed the spatial structure of the city. AMAC contains the principal administrative and commercial core of Abuja as well as expanding peri-urban and semi-rural settlements. The resulting combination of highly developed central districts and rapidly urbanising peripheral communities provides an appropriate setting for examining whether healthcare infrastructure has expanded in proportion to population and spatial development.

The problem is particularly important because spatial inequality may remain hidden when healthcare facilities are assessed only at the city or Federal Capital Territory level. Aggregate statistics can indicate that a large number of facilities exist without showing whether these facilities are concentrated in a small number of wards. The thesis on which this article is based identifies this gap explicitly, noting that much of the existing Nigerian research has been undertaken at state, city or inter-regional scales, with relatively limited attention to intra-urban and ward-level differences within AMAC.

GIS provides a useful framework for addressing this problem because it allows facility locations, administrative boundaries, population distributions and transportation infrastructure to be analysed together. Spatial techniques such as Nearest Neighbour Analysis, Kernel Density Estimation, Location Quotient and proximity analysis can reveal patterns that are not apparent from conventional descriptive statistics. The use of multiple spatial measures is particularly important because healthcare equity involves several dimensions, including facility concentration, population coverage and geographical accessibility. Recent studies have similarly employed GIS and spatial accessibility methods to identify underserved communities and support evidence-based allocation of health resources (Bihin et al., 2022; Florio et al., 2023).

The present study therefore examines the spatial inequality of healthcare provision within AMAC. It focuses on the distribution of healthcare facilities across wards, the degree of spatial clustering, the relative concentration of facilities in relation to population, the urban core–periphery pattern of healthcare provision and the implications of the observed spatial structure for accessibility and planning. The study contributes to the literature by providing a fine-scale

assessment of healthcare infrastructure within a rapidly growing African capital and by combining facility mapping with spatial statistical analysis and residents' perceptions.

2.0 Materials and Methods

The study was undertaken in Abuja Municipal Area Council, one of the Area Councils of the Federal Capital Territory of Nigeria. AMAC contains the principal administrative and commercial districts of Abuja, including Garki, Wuse, Central Area, Maitama and Asokoro, together with rapidly expanding peripheral settlements. The study area therefore incorporates both highly urbanised districts and peri-urban and semi-rural communities. The thesis identifies thirteen wards used in the analysis: Gwarimpa, City Centre, Kabusa, Garki, Wuse, Karu, Gui, Gwagwa, Orozo, Jiwa, Nyanya, Karshi and Kanshi/Karshi II. The area is characterised by rapid population growth and outward urban expansion, with the 2006 population of 778,567 projected in the study to approximately 1,416,213 by 2025 using an annual growth rate of 3.2%.

The research adopted a cross-sectional spatial analytical design. Primary data consisted of healthcare facility locations and attributes obtained through field survey and GPS mapping. Information relating to facility ownership, type and location was recorded during the field exercise. Secondary data were obtained from population records, administrative maps, policy documents, planning standards, institutional reports and published literature. The research methodology also incorporated satellite imagery and spatial data to understand settlement expansion and population distribution.

A questionnaire survey was undertaken to complement the spatial analysis. The study population comprised residents of AMAC. Using the projected population and the Krejcie and Morgan sampling framework, 384 respondents were selected. A multistage sampling approach was used, involving stratification into urban and peripheral areas, selection of communities and systematic selection of respondents or households. The questionnaire examined residents' perceptions of healthcare accessibility and the consequences of the existing spatial distribution.

The spatial analysis was conducted using GIS. Healthcare facilities were georeferenced and represented as point features, while ward boundaries and other relevant spatial layers were used to examine their distribution. The principal analytical techniques were Nearest Neighbour Analysis, Z-score significance testing, Kernel Density Estimation, Location Quotient, buffer and proximity analysis, and ward-level facility-to-population ratios. The methodology in the source

study explicitly combines these techniques to assess global spatial pattern, density, relative concentration and accessibility.

Nearest Neighbour Analysis was used to determine whether the facilities were spatially clustered, randomly distributed or dispersed. Kernel Density Estimation was applied to the georeferenced facility points to identify areas of relatively high and low healthcare concentration. Location Quotient was used to compare the share of facilities in each ward with its corresponding population share. An LQ greater than 1 represents relative over-concentration, whereas a value below 1 indicates relative under-concentration. Proximity and buffer analysis were used to assess the geographical relationship between healthcare facilities and surrounding residential areas.

The study also examined the ownership structure of facilities because public and private providers can respond differently to spatial demand. This distinction is important in a mixed healthcare system such as Nigeria's, where private providers may concentrate in economically attractive locations while public facilities have a stronger redistributive function. The source study identifies both public and private healthcare providers across AMAC and examines their spatial pattern in relation to urban structure.

The interpretation of accessibility was based primarily on geographical proximity rather than road-network travel time. This limitation is important because distance measured as a straight-line or buffer relationship does not fully capture congestion, road quality, public transport availability or actual travel time. Contemporary studies increasingly emphasise travel-time and network-based measures because the effective accessibility of healthcare depends on the impedance associated with reaching a facility rather than distance alone (Bihin et al., 2022; Mutono et al., 2022). The present analysis should therefore be understood principally as an assessment of spatial distribution and geographical proximity.

3.0 Results and Discussion

The field inventory identified 233 healthcare facilities across the thirteen wards of AMAC. The distribution was strongly uneven. Gwarimpa contained 37 facilities, representing 15.9% of the total, followed by City Centre with 27 facilities (11.6%), Kabusa with 26 (11.2%) and Garki with 25 (10.7%). Wuse contained 21 facilities (9.0%), Karu 20 (8.6%), Gui 19 (8.2%) and Gwagwa 17 (7.3%). At the lower end of the distribution were Jiwa with 13 facilities (5.6%), Orozo with 12 (5.2%), Nyanya with 10 (4.3%), Karshi with 4 (1.7%) and Kanshi with 2 (0.9%). The four

leading wards, Gwarimpa, City Centre, Kabusa and Garki, therefore accounted for 49.4% of all facilities in the inventory.

This concentration represents a substantial spatial imbalance. The four wards with the highest facility counts are predominantly established urban areas characterised by stronger infrastructure, commercial activity, administrative functions and relatively high development intensity. The concentration is therefore understandable from the perspective of market demand and urban centrality. However, the scale of the difference becomes problematic when viewed against the rapid expansion of peripheral settlements. Karshi and Kanshi together account for less than 3% of the facilities in AMAC, despite being part of a municipality experiencing continued spatial expansion.

The pattern is consistent with the wider Nigerian literature. Makinde et al. (2018) demonstrated substantial geographical disparities in healthcare facility provision in Nigeria, while Nwakeze and Kandala (2011) identified spatial differences in health-establishment distribution. Evidence from Ibadan similarly found significant clustering of healthcare facilities around the urban built-up area, with weaker clustering beyond the urban core. The AMAC results therefore appear to reflect a broader urban geography of healthcare in which facilities are attracted towards locations with stronger demand, better infrastructure and greater economic viability.

The Nearest Neighbour analysis further confirms that the facilities do not form a random spatial pattern. The study's spatial analysis identifies a clustered distribution, which is consistent with the earlier Federal Capital Territory assessment by Sagir et al. (2021). That study reported a Nearest Neighbour Ratio of 0.34 and a Z-score of -40.9, both statistically significant at $p < 0.001$, and concluded that the healthcare facilities in the FCT exhibited a strongly clustered pattern. The importance of the present study lies in taking the analysis to the ward scale and showing where the clustering occurs within AMAC.

Kernel Density Estimation provides further evidence of the spatial concentration. The KDE surface identifies the strongest concentration around Wuse, Garki, Gwarimpa and the City Centre, with the high-density corridor extending through the central urban districts. These areas combine high population densities, commercial activity, administrative functions, higher-income residential areas and better road accessibility. Moderate density occurs around Karu, Nyanya, parts of Gui and the Gwagwa/Dei-Dei axis, while Karshi, Kanshi, parts of Orozo and interior Jiwa contain relatively sparse facility distributions.

The KDE therefore demonstrates a clear core–periphery gradient. Healthcare density declines away from the central urban area and follows major transport and development corridors, including Airport Road, Kubwa Road and the Nyanya–Karu axis. This finding is important because it indicates that facility location is not independent of the wider urban spatial structure. Healthcare providers are located within the same corridors that concentrate population, commerce, employment and transportation.

The pattern is consistent with evidence from other African cities. Florio et al. (2023) found that geographic access to healthcare in sub-Saharan Africa generally follows the urbanisation continuum, with cities and peri-urban areas having higher accessibility than dispersed rural areas. Similarly, research in Ghana has shown that spatial access to health services varies within cities and that economically disadvantaged populations can experience poorer access. The AMAC findings suggest that similar processes are operating within a single metropolitan municipality, with the central city functioning as a major healthcare concentration zone while peripheral areas experience weaker service coverage.

The Location Quotient results provide a more direct measure of relative spatial concentration. Gwarimpa has the highest LQ at 2.06, followed by City Centre at 1.51, Kabusa at 1.45, Garki at 1.39, Wuse at 1.17, Karu at 1.12 and Gui at 1.06. Gwagwa is approximately proportionally represented, with an LQ of about 0.95. In contrast, Jiwa has an LQ of 0.73, Orozo 0.67, Nyanya 0.56, Kanshi 0.22 and Karshi only 0.11.

The contrast between Gwarimpa and Karshi is particularly important. An LQ of 2.06 indicates substantial over-concentration relative to the study's population-based distributional benchmark, while 0.11 represents severe under-concentration. The results therefore demonstrate that the inequality is not merely a difference in absolute numbers. It is a difference in the relative relationship between healthcare supply and population distribution. This supports the argument that facility counts alone are insufficient for evaluating urban healthcare equity.

The LQ pattern also provides a useful explanation of why a municipality can have a relatively large healthcare stock and still contain underserved communities. Where several facilities are concentrated within a small number of wards, additional facilities in those locations may contribute relatively little to territorial coverage. Conversely, establishing even a small number of appropriately located facilities in severely underserved wards may produce a much greater improvement in geographical equity. This principle is consistent with GIS-based facility-location

studies that emphasise the importance of optimal siting rather than simply increasing aggregate facility numbers. Otun (2023), for example, demonstrated through spatial decision-support modelling in Nigeria that existing facility locations could be substantially improved in terms of both efficiency and equity.

The ownership pattern reinforces the spatial distinction between the urban core and peripheral areas. The thesis identifies a mixed public-private healthcare system, with private facilities particularly prominent in Gwarimpa, Wuse, Karu, Gwagwa and Nyanya. City Centre and Garki show stronger public-sector concentrations, reflecting their administrative and institutional roles. Peripheral wards such as Karshi, Jiwa and parts of Orozo rely more heavily on public primary healthcare provision.

This distribution suggests that healthcare location is influenced by different institutional logics. Private providers tend to respond to population density, purchasing power, infrastructure and commercial viability. Public providers have a broader territorial responsibility and therefore remain important in locations where private investment is less attractive. The result is a spatially differentiated healthcare system. Urban wards may have greater diversity and density of providers, but the ability to use those services may depend on household income and affordability. Peripheral wards may have public facilities but a narrower range of services and fewer higher-order facilities.

This finding is consistent with the broader Nigerian healthcare environment in which public and private providers jointly constitute the health system. It also has implications for spatial justice. Private investment can increase overall service supply, but market-led distribution cannot by itself guarantee equitable access. Where purchasing power and commercial activity are spatially concentrated, private healthcare may reproduce existing socioeconomic geography unless public policy deliberately redirects investment towards areas of demonstrated need.

The proximity analysis indicates that residents of the urban core generally have shorter geographical distances to healthcare facilities, while peripheral populations experience greater distances, particularly when seeking secondary and tertiary services. The thesis reports that central wards commonly fall within approximately 1–2 km of healthcare facilities, whereas peripheral areas can face distances exceeding 3–5 km for higher-order services. The resulting pattern is consistent with the broader core–periphery structure revealed by the facility counts, KDE and LQ.

The accessibility finding is important because distance can influence healthcare utilisation, especially for low-income households, older people, persons with disabilities and residents who depend on public transportation. The literature increasingly treats geographical accessibility as a multidimensional concept involving distance, travel time, transport networks and facility characteristics rather than facility presence alone (Bihin et al., 2022). In sub-Saharan Africa, Florio et al. (2023) found that access varies substantially along the urbanisation continuum and that travel impedance remains a major determinant of effective access.

Evidence from Abuja itself is especially relevant. A recent study of emergency obstetric care accessibility across Nigerian cities found an intra-urban inequality pattern in Abuja, with accessibility differing by relative wealth and with functional services more concentrated in urban cores than peripheral suburbs. This independent evidence strengthens the interpretation of the present findings: the spatial inequalities identified in AMAC are not simply theoretical differences in facility counts but form part of a wider pattern in which the location of healthcare services interacts with the socioeconomic and spatial structure of Abuja.

The residents' survey provides further evidence of the practical implications of the spatial pattern. Of the 384 respondents, 61.2% agreed that the current distribution limits access for residents in rural communities, while 65.9% agreed that the facilities do not adequately meet population needs. The most pronounced concern was emergency response: 54.9% agreed and 31.5% strongly agreed that the spatial distribution hampers emergency response services, giving a combined 86.4% level of agreement. Similarly, 48.4% agreed and 36.7% strongly agreed that the distribution places pressure on healthcare personnel, representing 85.1% combined agreement.

The survey also indicates broader social and economic consequences. A combined 69.5% of respondents agreed or strongly agreed that the distribution contributes to unequal health outcomes, while 41.9% agreed that transportation challenges impair access. More than half (54.7%) believed that vulnerable groups are disproportionately affected, and 81.5% agreed that the existing distribution increases the cost of healthcare. A further 55.7% agreed that the pattern contributes to a preventive healthcare gap.

These perceptions complement rather than replace the spatial analysis. The questionnaire does not establish a causal relationship between facility distribution and mortality, morbidity or household healthcare expenditure. Nevertheless, the consistency between the spatial evidence

and residents' perceptions is noteworthy. Areas identified through GIS as relatively underserved are also associated with perceptions of greater access difficulty, transport burden and service pressure. This convergence strengthens the argument that spatial distribution is a meaningful planning issue.

Taken together, the findings indicate that the geography of healthcare provision in AMAC is shaped by urban centrality, road accessibility, commercial activity, administrative functions, population concentration and market viability. The current pattern can therefore be described as clustered, urban-core concentrated, infrastructure-oriented and spatially unequal. The thesis similarly concludes that facility locations correspond more closely with urban development and economic activity nodes than with a deliberate needs-based framework.

The policy significance of this finding is considerable. A strategy based simply on increasing the total number of healthcare facilities may fail to resolve the problem if new investment continues to flow disproportionately towards already well-served districts. Instead, planning should identify the spatial deficit areas and allocate new facilities according to population demand, existing service coverage and accessibility thresholds. GIS provides a practical mechanism for doing this because facility locations can be periodically updated as the city expands.

The study also points to the need for closer integration between health planning and urban development. AMAC's continuing expansion means that healthcare facilities established today may not provide adequate coverage for future populations. Residential layouts, new development corridors and peri-urban settlements should therefore be assessed for healthcare requirements before development becomes established. This approach would shift healthcare planning from a reactive response to population growth towards anticipatory infrastructure provision.

4.0 Summary of Findings

The study established that healthcare facilities in AMAC are strongly and unevenly distributed. The 233-facility ward inventory shows that nearly half of all facilities are concentrated in Gwarimpa, City Centre, Kabusa and Garki, while peripheral wards such as Karshi and Kanshi contain very small shares of the total. The distribution therefore exhibits a clear urban bias.

The spatial statistical analysis confirms that the observed distribution is clustered rather than random. Kernel Density Estimation identifies a high-density healthcare corridor around Wuse, Garki, Gwarimpa and the Central Area, while lower-density zones occur mainly in Karshi, Kanshi, Orozo and interior Jiwa. The pattern follows major transport and urban-development

corridors and is closely associated with infrastructure, commercial activity and administrative centrality.

The Location Quotient analysis demonstrates that the imbalance persists after considering population distribution. Gwarimpa has an LQ of 2.06, whereas Karshi has an LQ of 0.11. Several central wards are therefore relatively over-concentrated, while peripheral wards are substantially under-represented.

The ownership pattern reveals a spatially differentiated public-private system. Private providers are concentrated particularly in economically active urban and transitional wards, while public facilities play a more prominent role in administrative and peripheral areas. This suggests that market forces contribute significantly to healthcare location and that private-sector expansion alone is unlikely to produce territorial equity.

Accessibility analysis identifies a core-periphery gradient, with shorter geographical distances to healthcare services in central wards and longer distances in peripheral locations, particularly for secondary and tertiary care. Resident perceptions support the spatial analysis, with substantial proportions reporting problems relating to emergency response, personnel pressure, transportation, healthcare costs, vulnerable populations and preventive care.

Overall, the evidence indicates that healthcare provision in AMAC is not sufficiently aligned with a population-based spatial equity principle. The current distribution reflects the interaction of urban development, infrastructure, economic attractiveness and administrative centrality, with peripheral communities bearing a disproportionate share of the accessibility deficit.

5.0 Conclusion and Recommendations

The study concludes that healthcare provision in Abuja Municipal Area Council is characterised by pronounced intra-urban spatial inequality. Although AMAC contains a substantial number of healthcare facilities, these facilities are not distributed evenly across its wards. The strongest concentrations occur in established urban and administrative districts, while several peripheral wards remain comparatively underserved. The convergence of facility counts, spatial clustering, Kernel Density Estimation, Location Quotient and proximity analysis provides consistent evidence of a core-periphery healthcare geography.

The results further demonstrate that the problem is not simply a shortage of healthcare facilities but a spatial mismatch between service locations and population needs. The concentration of facilities in high-demand and economically viable districts may be rational from a market or

operational perspective, but it becomes inequitable when peripheral population growth is not accompanied by corresponding infrastructure. This is particularly important in a rapidly expanding capital city where urbanisation is continuously creating new demand beyond the established service core.

Healthcare planning authorities in AMAC should therefore institutionalise GIS-based spatial analysis as part of routine facility planning. New healthcare facilities should be located using evidence on population distribution, existing facility density, service gaps, projected urban growth and accessibility rather than relying primarily on administrative convenience or market demand. The spatial analytical framework used in this study provides a practical starting point for such decision-making.

Investment should be prioritised in wards identified as relatively underserved, particularly Karshi, Kanshi, Orozo and Jiwa, while the accessibility situation of other rapidly expanding peripheral wards should be periodically reassessed. New primary healthcare centres, upgraded facilities and mobile outreach services should be considered where population growth and distance from existing facilities justify intervention.

Public healthcare infrastructure should also be strengthened. The presence of private providers is valuable to the healthcare system, but private facilities are unlikely to locate consistently in communities where purchasing power and commercial returns are limited. Public investment therefore remains necessary to achieve minimum territorial coverage and to protect vulnerable households from the affordability consequences of market-led provision.

Healthcare planning should be integrated directly into urban development policy. New residential layouts and major urban expansion corridors should make provision for healthcare infrastructure before development approval. This would allow healthcare supply to anticipate population growth rather than continually responding after settlement has already occurred.

Public-private partnerships should be encouraged but spatially regulated. Incentives such as access to serviced land, planning concessions or other appropriate measures could encourage private providers to establish facilities in underserved areas. Such incentives should be accompanied by regulatory requirements relating to service quality, affordability and continuity. Finally, future research should extend the present analysis from Euclidean proximity to road-network travel time and incorporate facility capacity, staffing, service quality and socioeconomic characteristics. Contemporary evidence from Nigeria demonstrates that intra-urban accessibility

can vary according to wealth, transport conditions and the availability of functional facilities. A network-based model would therefore provide a stronger basis for identifying communities that are not merely distant from healthcare facilities but are genuinely disadvantaged in terms of travel time and effective service access.

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