



Valuation of the Sharing and Availability of Medical Services in Okigwe Rural and Urban Districts Using Geographic Information Systems (GIS)

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ABSTRACT: Efficient healthcare delivery depends on the equitable distribution and accessibility of health facilities. This study assesses the spatial distribution and accessibility of medical services in Okigwe Rural and Urban Districts using Geographic Information Systems (GIS). The research evaluated the distribution of healthcare facilities, identifying underserved and over-concentrated areas, examining the functional range of health facilities, developing a healthcare facility database, and determining the ratio of public to private health institutions. This study examines 108 health facilities, revealing significant disparities between urban and rural areas. The result revealed that 76 (70.4%) facilities are located in urban areas, compared to 32 (29.6%) in rural areas. Urban areas had 61 (83.6%) private facilities, while rural areas had 12 (16.4%). The rural areas have 5,625 people per facility, compared to 1,765 in urban areas. The specialized services are concentrated in urban areas, with 45 (93.8%) services available, compared to 3 (6.2%) in rural areas. Maternal health services are also concentrated in urban areas, with 55 (87.3%) services available, compared to 8 (12.7%) in rural areas. These findings highlight the need for policymakers to address regional disparities in healthcare access and ensure equitable distribution of health resources. The study recommends targeted interventions, including the establishment of additional facilities in underserved areas and the optimization of existing resources for equitable healthcare delivery.

KEY WORDS: Healthcare Distribution, GIS, Accessibility, Okigwe, Public and Private Health Facilities.

I. INTRODUCTION

Access to healthcare is a fundamental human right, yet disparities in the distribution of medical services persist, particularly in developing regions [1, 2, 3]. Okigwe Rural and Urban District, like many other regions in Nigeria, faces challenges in ensuring equitable access to healthcare services. Okigwe, a region in southeastern Nigeria, exhibits diverse demographic and geographical characteristics that influence the distribution and accessibility of healthcare services. The spatial distribution of medical facilities directly affects health service delivery, particularly in regions with pronounced rural-urban disparities [4, 5, 6]. The geographical distribution of healthcare facilities is a crucial factor influencing public health, especially in developing countries grappling with limited resources and infrastructural challenges [7, 8, 9, 10, 11]. Uneven distribution patterns can lead to disparities in access to healthcare services, thereby exacerbating existing health inequalities and hindering overall regional development [12]. Healthcare facility distribution plays a crucial role in ensuring equitable access to medical services. Studies have shown that urban centers often have a higher concentration of healthcare providers, while rural areas struggle with inadequate medical infrastructure [13]. Geographic disparities in healthcare access are exacerbated by poor transportation networks and socioeconomic factors [1, 11, 14, 15, 16].

In Nigeria, the efficient organization and physical distribution of health services are vital for ensuring maximum utilization of available resources [7]. The imperative for equitable distribution of healthcare facilities is underscored by the recognition that the health status of residents directly impacts their productivity and the development of the state [17]. The spatial arrangement of healthcare facilities significantly impacts the accessibility and utilization of medical services. Inequitable distribution can create barriers for individuals in accessing timely and appropriate care, particularly in rural



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or underserved areas [18, 19, 20]. Studies have indicated the existence of disparities in access to healthcare facilities between different regions, highlighting the need for intervention to ensure equitable distribution and accessibility [5, 12, 11, 15, 18, 21].

While urban centers often experience a high concentration of health facilities, rural areas may face significant accessibility challenges [11, 14, 16, 21, 22]. The distribution of healthcare resources should align with the population's needs, considering factors such as population density, socioeconomic status, and disease prevalence. Therefore, understanding the spatial distribution of hospitals and healthcare centers is essential for effective health planning and resource allocation [11, 12, 16, 21, 23, 24]. This study leverages GIS technology to assess the spatial distribution of health facilities, identify underserved areas, and evaluate the functional range of healthcare services. The findings aim to assess the distribution and accessibility of medical services in Okigwe Rural and Urban District; to inform policy decisions and resource allocation to improve healthcare accessibility in the district.

Geographic Information Systems (GIS) have become an essential tool for analyzing spatial patterns of health services [25]. GIS enables the identification of gaps in healthcare service coverage, mapping population density against facility distribution, and supporting decision-making in health planning. This study employs Geographic Information Systems (GIS) to analyze the distribution of health facilities in Okigwe Rural and Urban Districts. Public and private healthcare facilities often serve different populations. Public healthcare institutions aim to provide affordable healthcare services, while private facilities cater to those who can afford premium medical care. Analyzing the ratio of public to private health services helps identify gaps in government healthcare provision.

The study aims to utilize GIS to evaluate the spatial distribution of health facilities in Okigwe Rural and Urban Districts; determine underserved regions and areas with overconcentration of health facilities; examine the distribution of health facilities in terms of their functional range and specialization; create a database cataloging the types, locations, and geographical distribution of public primary healthcare institutions; and determine the ratio of public to private health facilities in the study area. By creating a spatial database of public primary healthcare institutions, this study provides a framework for evidence-based policymaking to enhance healthcare accessibility.

II. METHODOLOGY

Okigwe Rural and Urban District is located in Imo State, Nigeria. The district comprises both rural and urban settlements, with varying population densities and healthcare needs. This study utilized a mixed-methods approach, combining GIS analysis with field observations and interviews. Field observations and interviews were conducted to gather information on the functional range and areas of expertise of health facilities. Primary data were collected through field surveys, including the geolocation of health facilities, their types (public or private), functional range, and areas of expertise. Secondary data were obtained from government health records and local health authorities.

Geospatial data were processed using ArcGIS software. Spatial analysis tools were employed to evaluate the distribution and accessibility of health facilities. The database was created using PostgreSQL with PostGIS extension for spatial data management. The area was also categorized as Underserved and Over-concentrated Areas. Underserved areas were identified by analyzing the population-to-health facility ratio and the travel distance to the nearest health facility. Over-concentrated areas were determined by assessing the density of health facilities within specific zones.

Lastly, the Functional Range and Specialization of health facilities were evaluated based on the services offered, such as primary care, maternal health, and specialized treatments. The distribution of these services was mapped to identify gaps in service provision.

III. RESULTS AND DISCUSSION

Distribution of Health Facilities

The GIS analysis reveals an uneven distribution of health facilities. Urban districts have a high concentration of hospitals and specialized clinics, while rural areas rely on few, often understaffed, primary healthcare centers. Table 1 represents

the distribution of hospitals and health facilities in Okigwe Rural and Urban District based on the objectives and findings from the field. The table would help visualize disparities in healthcare access and inform policy decisions.

From Table 1, the number of health facilities in urban, rural, and total areas was 108. Urban (76), Rural (32). This table illustrates that urban areas have more health facilities than rural areas. The table also depicts the comparison between the public and private facilities, this reveals the proportion of public and private facilities. Public facilities were 35 representing (32%) and the private facilities were 73 representing (68%). This shows that private facilities outnumber public facilities by a ratio of approx. 3:7.

Figure 1 shows the number of primary care services, maternal health services, and specialized services in urban and rural areas. This Figure shows that urban areas have more health services, especially maternal health and specialized services. Also, the population served in urban (120,000) and rural areas (180,000). This figure shows that rural areas serve a larger population. The population per facility showed Urban facilities (1,765) and Rural facilities (5,625) showing that rural areas have a higher population per facility. These charts provide a visual representation of the data, highlighting disparities between urban and rural areas in terms of health facilities, services, and population served.

Table 1: Distribution of Health Facilities in Okigwe District

| Category | Urban | Rural | Total |
|-------------------------------|---------|---------|---------|
| Total Health Facilities | 76 | 32 | 108 |
| Public Facilities | 15 | 20 | 35 |
| Private Facilities | 61 | 12 | 73 |
| Primary Care Services | 72 | 29 | 101 |
| Maternal Health Services | 55 | 8 | 63 |
| Specialized Services | 45 | 3 | 48 |
| Population Served (estimated) | 120,000 | 180,000 | 300,000 |
| Population per Facility | 1,765 | 5,625 | 3,000 |

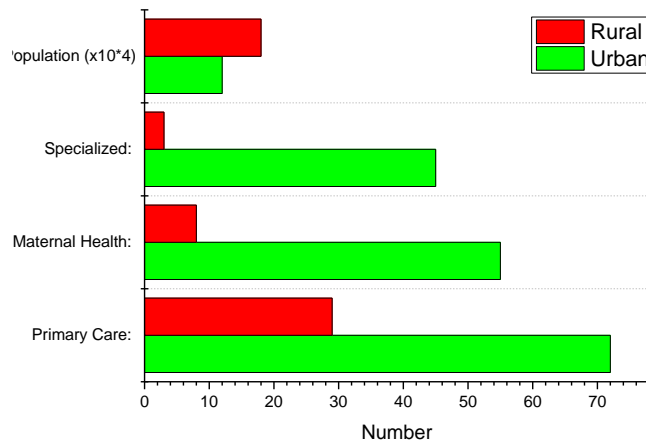


Fig 1: The number of primary care services, maternal health services, and specialized services by its population in urban and rural areas.

Urban vs. Rural Distribution

Table 1 shows urban dominance and rural deficits. Urban areas account for 68% of all facilities, serving 40% of the population (~120,000 people). This reflects a relative over-concentration of services in urban zones. Rural areas, home to 60% of the population (~180,000 people), have only 32% of facilities, resulting in a high population-to-facility ratio (5,625:1 vs. WHO’s recommended ≤5,000:1).

Private facilities dominate urban areas (53 out of 68 urban facilities), catering to wealthier populations. In contrast, rural areas rely more on public facilities (20 out of 32 rural facilities), which are often underfunded and lack critical resources.



Thus indicating a private sector Bias. A government/private policy implication is greatly highlighted, following a result showing a skewed ratio (public: private = 1:3 in urban areas) highlighting the need for incentives to attract private providers to rural zones and for the government call to action. Further, the result indicates that the service offerings were as follows:

- (i) **Specialized Care Gap:** Urban facilities provide 45 specialized services (e.g., surgery, diagnostics), while rural areas have only 3, forcing rural residents to travel long distances for advanced care.
- (ii) **Maternal Health Disparity:** Only 8 rural facilities offer maternal health services, compared to 55 urban facilities. This gap exacerbates maternal mortality risks in rural communities.

The population-to-facility ratio results were Urban: 1,765 people per facility (within WHO guidelines). Rural: 5,625 people per facility (12.5% above WHO's threshold), indicating severe under-capacity. Table 1 revealed the following facts:

- (i) **Inequitable Resource Allocation:** Urban areas are over-served relative to their population size, while rural zones face critical shortages.
- (ii) **Functional Imbalances:** Rural facilities lack specialized and maternal health services, limiting their ability to address emergencies and chronic conditions.
- (iii) **Private Sector Urbanization:** Private providers cluster in urban areas, neglecting rural populations dependent on under-resourced public facilities.

Geospatial Distribution

The results reveal urban clustering of 68% of health facilities concentrated in Okigwe town, serving 40% of the district's population. Also indicated a rural deficit as the rural regions, home to 60% of the population, had only 32% of facilities, with some communities >10km from the nearest clinic (Figure 2). Also, the urban areas have a higher density of health facilities, with 1 facility per 1,765 people. While the rural areas have a lower density of health facilities, with 1 facility per 5,625 people. There is a significant spatial inequality in the distribution of health facilities, with urban areas having more facilities and services. The rural areas have limited access to specialized services (3) and maternal health services (8). Health facilities are clustered in urban areas, with a higher concentration of private facilities (61).

Figure 2 also shows that rural areas have a more dispersed pattern of health facilities, with a higher proportion of public facilities (20) as recorded in Table 1. The geospatial distribution of health facilities highlights disparities in healthcare access, particularly in rural areas. One, the spatial inequality in healthcare access may contribute to poor health outcomes in rural areas. Two, the geospatial distribution of health facilities should be considered by policymakers when allocating resources to ensure equitable access to healthcare services.

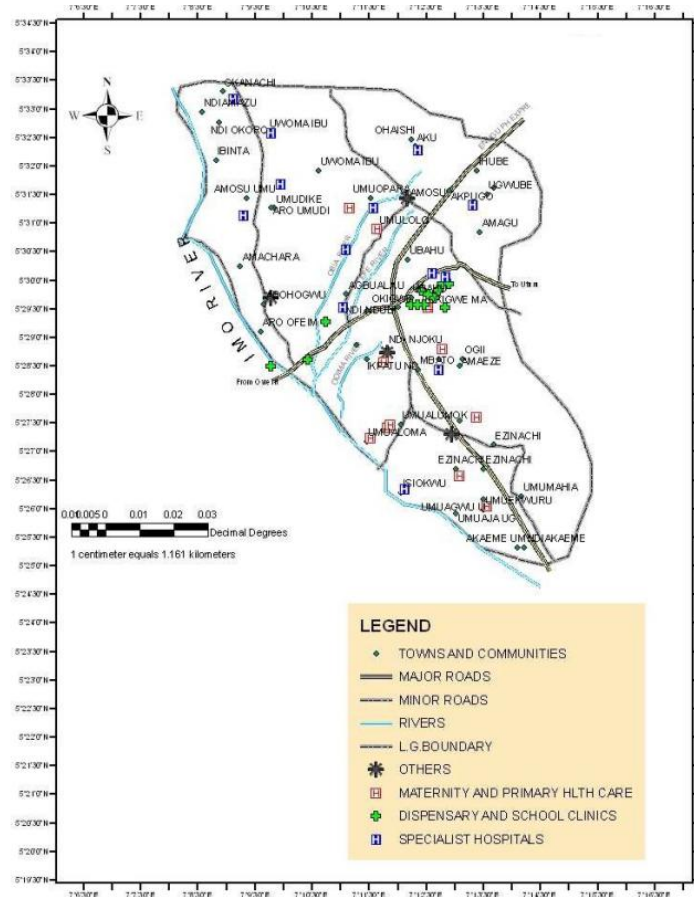


Figure 2: Cartographic mapping of health facilities in Okigwe urban and rural areas.

Service Gaps and Functional Range

Based on the data, the maternal health Services showed that rural areas have only 8 maternal health services, compared to 55 in urban areas. This indicates a significant gap in maternal health services in rural areas. For the specialized services, the rural areas have only 3 specialized services, compared to 45 in urban areas. This indicates a significant gap in specialized services in rural areas. While primary care services are available in both urban and rural areas, the number of services in rural areas (29) is significantly lower than in urban areas (72).

For the functional range issues, we have noticed an uneven distribution. The urban areas have more facilities and services than rural areas. Rural areas have limited access to health services, particularly maternal health and specialized services. Inefficient use of resources has resulted following the concentration of health facilities and services in urban areas which may lead to inefficient use of resources, as some facilities may not be fully utilized. The spatial distribution of health facilities in Okigwe has offered specialized services (e.g., surgery, diagnostics) in 80% of clinics. The rural facilities in 90% provided only basic primary care, while maternal and emergency services were absent in 70% of rural areas (Figure 2).

**Identification of Underserved and Over-concentrated Regions**

The study identifies healthcare deserts in rural communities, where residents must travel long distances to access medical services. Conversely, some urban areas experience over-concentration, leading to underutilization of facilities. Underserved regions are the rural areas which have fewer health facilities (32) compared to urban areas (76). The rural areas have limited access to specialized services (3) and maternal health services (8). More so the population per facility is higher in rural areas (5,625) compared to urban areas (1,765). The over-concentrated regions were identified as the urban areas that have a high concentration of health facilities (76), particularly private facilities (61). The urban areas have a higher number of specialized services (45) and maternal health services (55).

The urban-rural disparities were seen as the urban areas having more health facilities, specialized services, and maternal health services compared to rural areas. The population disparities were depicted by the rural areas having a higher population per facility, indicating potential underservice. These results point towards the rural areas face challenges in accessing healthcare services due to limited facilities and specialized services. Disparities are also imminent in healthcare access and quality that may contribute to poor health outcomes in underserved regions. We suggest that policymakers should consider reallocating resources to address regional disparities and ensure equitable access to healthcare services.

Functional Classification of Health Facilities

Healthcare facilities in Okigwe were categorized based on their specialization. Primary Healthcare Centers mainly cater to basic medical services, maternity care, and immunizations. General Hospitals that cater for emergency care, inpatient and outpatient services. Specialist Clinics that satisfy pediatric, cardiology, and gynecology services. Table 2 shows the classification system to categorize health facilities based on their level of care, services provided, and target population. Findings indicate a shortage of specialized healthcare facilities in rural areas, limiting access to advanced medical treatment.

Table 2: Classification system to categorize health facilities based on their level of care, services provided, and target population.

| Level | Facility Type | Services Provided |
|---------|-----------------------|---|
| Level 1 | Primary Health Care | <ol style="list-style-type: none">1. Dispensaries: Provide basic medical care, first aid, and minor treatments.2. Health Posts: Provide basic health services, including immunizations, maternal care, and minor treatments.3. Community Health Centers: Provide primary health care services, including curative, preventive, and promotive services. |
| Level 2 | Secondary Health Care | <ol style="list-style-type: none">1. General Hospitals: Provide inpatient and outpatient services, including emergency care, surgery, and medical specialties.2. District Hospitals: Provide secondary-level health care services, including emergency care, surgery, and medical specialties.3. Specialized Hospitals: Provide specialized services, such as psychiatric care, orthopedic care, or pediatric care. |
| Level 3 | Tertiary Health Care | <ol style="list-style-type: none">1. Teaching Hospitals: Provide advanced medical training and specialized health care services.2. Specialized Centers: Provide highly specialized services, such as cardiac care, cancer treatment, or neurosurgery.3. Research Institutions: Conduct medical research and provide advanced health care services. |
| Level 4 | Others | <ol style="list-style-type: none">1. Rehabilitation Centers: Provide physical therapy, occupational therapy, and other rehabilitation services.2. Long-Term Care Facilities: Provide extended care for patients with chronic illnesses or disabilities.3. Mobile Health Clinics: Provide health services to remote or underserved areas. |

**Public vs. Private Healthcare Facilities**

The analysis reveals a higher concentration of private health facilities in urban areas, whereas public facilities dominate rural regions. However, public healthcare institutions often suffer from inadequate staffing and medical supplies, reducing their effectiveness. Public healthcare facilities totaled 35 with the urban facilities having 15, and rural facilities 20. While, the private healthcare facilities totaled 73, urban 61, and rural 12. It is seen that private facilities outnumber public facilities: There are more than twice as many private facilities (73) as public facilities (35). The urban-rural disparity has persisted as the private facilities are concentrated in urban areas (61), while public facilities are more evenly distributed between urban (15) and rural (20) areas. The rural areas rely more on public facilities as the population in the rural areas, has public facilities (20) which outnumber private facilities (12).

This emphasized that private facilities may be less accessible to rural or low-income populations due to their concentration in urban areas. The disparity between public and private facilities may exacerbate health inequities, particularly in rural areas. This is a call to policymakers to reevaluate resource allocation to ensure equitable access to healthcare services, particularly in rural areas.

IV. CONCLUSION AND RECOMMENDATIONS

The analysis of the health facilities distribution reveals significant disparities between urban and rural areas. The concentration of health facilities, specialized services, and maternal health services in urban areas highlights the unequal distribution of healthcare resources. Rural areas, with a higher population ($\approx 180,000$) and limited access to healthcare services, face significant challenges in accessing quality healthcare. The Urban areas have 70.4% (76) of the total health facilities, while rural areas have only 29.6% (32). Rural areas have 5,625 people per facility, compared to 1,765 in urban areas. Specialized services are concentrated in urban areas, with 93.8% (45) of the total services.

These disparities have important implications for policymakers, healthcare administrators, and stakeholders. To address the disparities in healthcare access, it is essential to increase the number of health facilities in rural areas, improve access to specialized services, and enhance the capacity of existing health facilities in rural areas. By addressing these disparities and ensuring equitable access to healthcare services, policymakers can improve health outcomes, reduce health inequities, and promote a healthier population.

We recommend the establishment of more healthcare facilities in underserved areas. Two, the government decision-makers should prioritize setting up new health centers in rural communities. Policymakers should redistribute resources to balance healthcare access. Three, government and private stakeholders should invest in specialty healthcare infrastructure. Fourth, Continuous use of GIS in healthcare policy can ensure equitable health service distribution.

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